



# Forest Landscape Analysis and Design

A Process for Developing and Implementing Land Management Objectives for Landscape Patterns

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A Process for Developing and  
Implementing Land Management  
Objectives for Landscape Patterns

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# CHAPTER 1 Introduction



OBJECTIVES AND PURPOSE  
SCOPE  
ORGANIZATION





## OBJECTIVES AND PURPOSE

The purpose of this publication is to provide a means by which forest landscapes can be understood as ecological systems, and to use this knowledge to help shape the landscapes created through National Forest land management activities.

There is a saying that captures the need for doing this:

*“If you don’t know where you’re going, any road will take you there.”*

Landscape patterns have evolved on Pacific Northwest Region National Forests in basically an unplanned way, through a sequence of implementation of individual activities, usually timber sales. Although individual projects were normally well planned and executed, rarely was any analysis done of how the emerging landscape pattern might affect resources (especially biological resources) or human interactions. Exceptions were analyses of cumulative hydrologic effects, viewshed plans, and transportation plans.

Thus, ecosystem function at the landscape level in National Forests has received little attention until relatively recently. Its importance has become apparent in recent years, with the explosion of criticism against the visual appearance of National Forests, the reduction in amount of old growth and the possibility that the developing landscape pattern jeopardizes species dependent on certain habitat characteristics.

This publication came into being, therefore, to assist National Forest managers in addressing landscapes as ecosystems. The document presents basic ecological information about landscapes, and proposes a strategy for designing landscape patterns that provide a synthesis of ecological functions with objectives and policies established through the Forest Planning process.

As long as forest management agencies carry out activities that change vegetation, new landscape patterns will be created. A paramount question is: “Will we allow that process to be informed by our understanding of landscapes as ecological systems, or will landscape patterns continue to evolve as a proliferation of independent actions”? The hope is to encourage a more enlightened, purposeful and objective development of forest landscapes.

**SCOPE**

This publication presents a Landscape Design and Analysis Process, along with some simple methods and tools for describing landscapes and their function. The information is qualitative in nature and highlights basic concepts, but does not address landscape ecology in great depth. Readers are encouraged to consult the list of selected references in Chapter 2 if they wish a more extensive background.

There are many unanswered questions about how landscapes operate as ecological systems. Those who attempt to carry out the Landscape Analysis and Design Process should expect to identify a number of information needs that simply cannot be met. For example, little is known about how individual wildlife species respond to landscape patterns, and how much flexibility there is in landscape level habitat needs. There is also incomplete understanding of the role of connectivity in landscapes, and how corridors do or don't function. In spite of this, there ARE data, inferences and interpretations that SHOULD be used as development of landscape patterns in National Forests continues.

The examples presented are for forests west of the Cascade crest. The information is probably generic enough to be extrapolated to most National Forest landscapes. The greatest exception will be flat landscapes, where relationships between vegetation and landforms are subtle. In these areas it may be difficult to apply the spatial design step of the process, since it depends heavily on landforms.

The strategy presented is intended to be in harmony with existing policies, direction, Forest Plan Standards and Guidelines, and land allocations. In some cases analysis of landscape relationships might indicate desirability of changing the Forest Plan land allocation of a particular management area to better meet stated objectives or standards/guidelines. In that instance, it is appropriate for the Forest Plan adjustment process to be invoked. However, the Landscape Analysis and Design Process should initially be viewed as a means of implementing current direction, not changing it.

This document purposely avoids making recommendations about the level of detail, size of area, scope of analysis, amount of quantification, and other details. These items must be determined in light of the characteristics of individual analysis areas and the needs of individual planning teams. Rather than attempt to force uniform application of the specifics, it is the LOGIC of the process that will be emphasized:

- 1) that the landscape be understood as an ecological system,

- 2) that that understanding is used along with existing direction and local issues to derive objectives about landscape pattern, and
- 3) that the spatial design of that pattern be used to inform and evaluate the progressive implementation of land management strategies.

This document is divided into 5 main sections. Chapter 1 (this Chapter) outlines the purpose and content. Chapter 2 presents the ecological basis for understanding and using the Landscape Design and Analysis Process. Chapter 3 discusses the context of National Forest planning activities, and the role of this process within it, including contributions of individual resource areas. Chapter 4 outlines the steps of the Landscape Analysis and Design Process, and presents examples. Finally, Chapter 5 discusses some of the common questions that have arisen about the application of the process.

## ORGANIZATION



# Landscapes as Ecological Systems

CHAPTER 2



## CONCEPTS OF ECOLOGICAL SYSTEMS

STRUCTURE AND FUNCTION

SCALES

RESILIENCE, DIVERSITY  
AND LAND MANAGEMENT

## THE ECOSYSTEM MODEL APPLIED TO LANDSCAPES

LANDSCAPE ELEMENTS  
AND PATTERN

LANDSCAPE FUNCTIONS

LANDSCAPE RESILIENCE  
AND DIVERSITY

## SELECTED REFERENCES

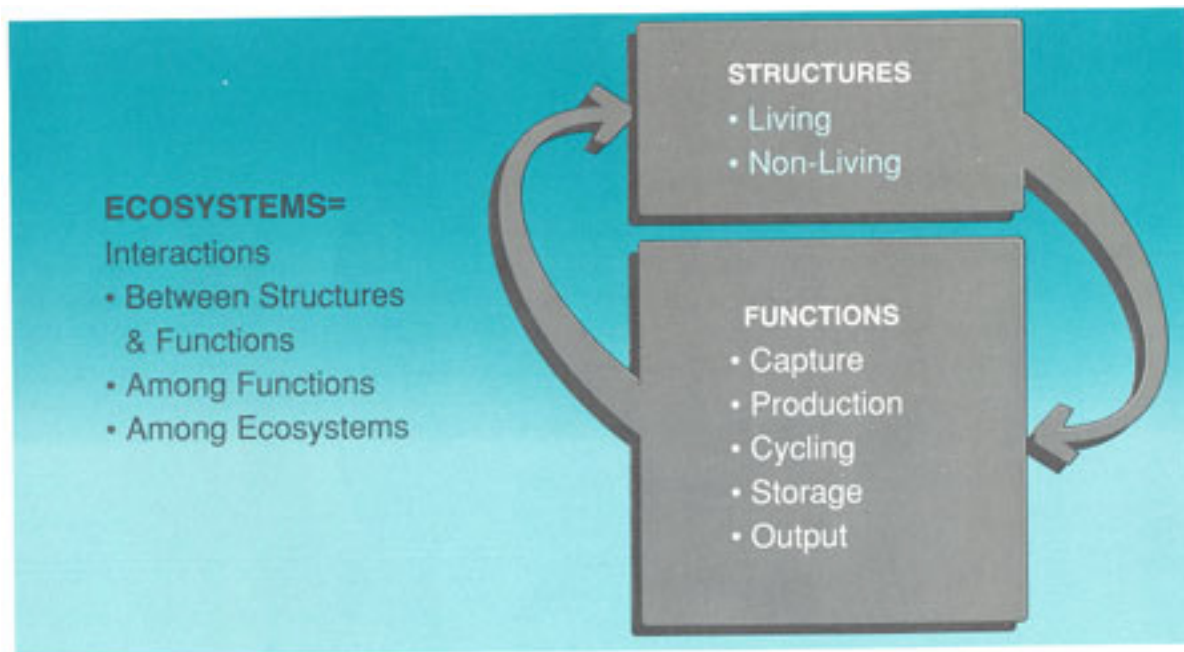




This Chapter contains concepts of landscape ecology useful in working through the Landscape Analysis and Design Process presented in Chapter 4. This discussion barely scratches the surface of the conceptual framework of systems and landscape ecology, let alone the details. To do a thorough landscape analysis, additional reading is advised. Readers are referred to the list of references at the end of this chapter, and encouraged to become familiar with the literature. Special attention to the text *Landscape Ecology* (Forman and Godrun, 1986) is recommended.

Before discussing landscapes in particular, it seems appropriate to present a basic model of ecological systems that applies regardless of scale. In other words, no matter whether the system being considered is a culture of organisms in a Petri dish, a tide pool, a forest stand, a major stream drainage, a region, or planet Earth, ecologists can use the same basic systems framework to understand it.

Figure 1 suggests there are three major components to understanding ecological systems: structures, functions, and the interactions among them.



## CONCEPTS OF ECOLOGICAL SYSTEMS Structure and Functions

Figure 1 - Generalized ecosystem structure/function model

Structures are the physical, tangible elements of systems, the things we can touch, see and feel. They can be living or non-living, mobile or fixed. Functions are the activities, roles or processes performed by structures. Ecosystem functions can be classified in many ways; five main types are generally recognized:

**Capture** (input) - resources (organisms, materials and energy) are brought into the system (e.g., photosynthesis, migration of an organism into seasonal range)

**Production** - resources are “manufactured” within the system (e.g., plant growth, animal reproduction, snags becoming down wood)

**Cycling** - resources are transported within the system (e.g., animal migration within a system, nutrient cycling within a forest stand, snow melting and becoming surface or groundwater flow)

**Storage** - resources are conserved within the system (e.g., sediments retained in wetlands, carbon and other nutrient storage in down wood)

**Output** - resources leave the system (e.g., animals migrate out of seasonal range, mass erosion, removal of commercial products)

Structures often are involved in more than one function, and a function often requires more than one structure. For example, a single animal species may function as both predator and prey. Or, it takes both open foraging habitat and forested cover to provide for the needs of some animal species. This leads to the third component, interactions. Functional interactions among ecosystem elements is what makes a system dynamic. To understand how a system works as a whole, relationships among the parts must be described. There are three kinds of interactions that can be considered. First, interdependencies exist among functions: for example, in order for production to be sustained, capture and cycling have to occur. Secondly, structures and functions are dependent on each other:

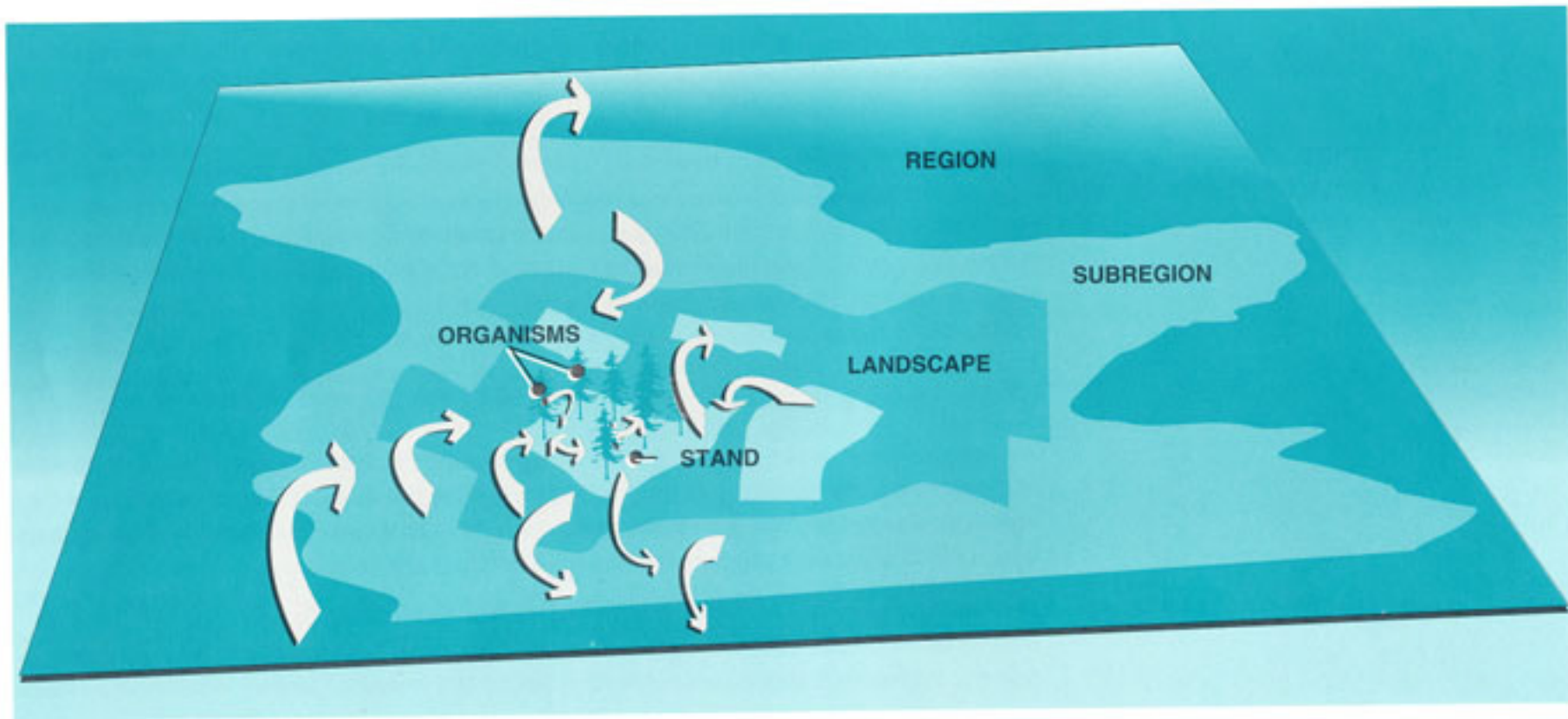
*“An endless feedback loop:  
Past functioning has produced today’s structure;  
today’s structure produces today’s functioning;  
today’s functioning will produce future structure.”<sup>1</sup>*

1. Forman and Godron, 1996

Finally, there are interactions BETWEEN ecological systems. No system is completely isolated; to fully understand an ecosystem, its structural and functional linkages to other systems must be described. To complicate the basic model, additional interactions occur among systems at different scales, or levels of spatial resolution (Forman and Godrun, 1986). For example, within a landscape, besides the landscape-scale processes taking place, there is a vast array of stand, population and individual organism processes, some of which are nested within each other and some of which overlap (Figure 2).

## Scales

**Figure 2 - Levels of organization of ecological processes. Interactions among processes within the same level, and also between levels.**



**Resilience, Diversity, and Land Management**

Ecosystem resilience is a concept of great importance in forest land management. It can be defined as “the ability of an ecological system to maintain its functions (capture + production + cycling + storage + output) in the face of change or disturbance”.

Ecosystems vary in the degree to which they can absorb change and still retain their variety of functions. In Pacific Northwest forests, it is generally accepted that resilience is conferred by inherent diversity and complexity. Since ecosystem functions are dependent on the structures that perform them, it follows that changes which eliminate certain structural features can cause loss of function in a system. Thus, management to sustain ecological resilience involves identifying and protecting individual types of structural elements, functions and interrelationships, with the objective of maintaining the overall function of the whole. It follows that land management that focuses on sustaining production (only ONE of the five ecosystem functions) of selected structures or functions, based on economics, aesthetics and other public values, has the potential to lead to inadvertent loss of less “valuable” structures or functions, which may in fact be key to the health of the whole system. Natural wildfire is an example.

**THE ECOSYSTEM MODEL  
APPLIED TO LANDSCAPES**

The first task in understanding landscapes as ecological systems is to define the term “landscape”. Forman and Godron (1986), define a landscape as “... a heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form throughout.” For Pacific Northwest forests, that translates to areas drained by major streams, within which climatic regime, geomorphic processes and natural vegetation patterns are fairly uniform. A landscape is larger than a stand and smaller than a region, and thus can vary greatly in size. In reality, it is probably less important to precisely define what a landscape is than to understand the relationships between the processes that go on in a landscape and the structures necessary to sustain them.

As stated in the previous Chapter, the intent of this publication is not to present a thorough review of all the concepts of landscape ecology, and readers are urged to consult the list of references at the end of this Chapter for additional reading. What follows is a brief summary of some highlights, taken largely from Landscape Ecology by Forman and Godron (1986).

**Resilience, Diversity, and Land Management**

Landscapes are commonly described as having three kinds of structures (which are referred to collectively as “landscape elements”): a matrix, corridors and patches. Usually vegetation (community type and successional stage) the most obvious feature of a landscape element, sometimes as modified by

landforms or other factors. In addition to the characteristics of individual landscape elements, their arrangement or pattern on the landscape is of interest.

The matrix is defined as the most connected portion of the landscape, that is, the vegetation type that is most contiguous. An analogy is that of a chocolate chip cookie: the cookie portion is the matrix, while the chocolate chips are “patches.” In Pacific Northwest forests, the matrix, usually some type of mature forest, is generally also the landscape element with the greatest area. This becomes increasingly LESS true as forests become fragmented by clearcutting, where in some cases it may not be possible to discern a matrix at all. In extensively cutover landscapes, the matrix may actually have shifted from mature forest to early successional forest. An important ecological feature of the matrix is that it is thought to exert strong control over landscape flows (movement of materials, energy, and organisms) because of the connectivity of habitat it provides.

It is worth noting that definition of what is or isn't a matrix is somewhat dependent on the scale of analysis. For example, in the Pacific Northwest region, WITHIN a National Forest landscape, mature forest is typically the matrix. But at a larger, State-wide or Regional scale, forests might appear as patches within an urbanized/agricultural landscape.

Patches are areas of vegetation that are relatively homogeneous internally (with respect to composition, successional stage, etc.) and that differ from what surrounds them (the matrix, or other patches). For example, in a forested landscape clearcuts, wetlands, and rock outcroppings are common patch types within the forested matrix. In a complex landscape where a matrix is not apparent, forest stands are also patches.

Corridors are landscape elements that connect similar patches through a dissimilar matrix or aggregation of patches. A mature forest riparian zone that connects patches of mature forest in a cutover landscape is an example. The patches connected by corridors are often called nodes. Roads can also be considered corridors, connecting early successional patches (clearcuts). Different kinds of corridors facilitate flow (the cycling function) of different materials or organisms. A given corridor (a road, for example) may function as a corridor for some organisms (humans) and a barrier for others (slugs). The effectiveness of a corridor to provide connectivity often depends on how wide it is (how much is actually edge), and how frequently breaks, or discontinuities, are encountered.

The pattern of the matrix, patches and corridors in landscapes is of primary interest, since it is really the spatial arrangement of these elements that determines the function of a landscape as an ecological system. The list of references at the end of this Chapter contains publications that discuss quantification of landscape pattern. Some of the most common terms used to describe landscape elements and patterns are below:

**Composition** - the physical and biological characteristics of a landscape element. In other words, the type of vegetation present, in terms of the species, age class, and physiognomic features. Composition is a very basic but important attribute of landscape elements, since it determines how a patch, corridor or matrix interacts with various landscape flows. For example, a mature Douglas-fir forest retains snow differently from an early successional Douglas-fir forest; a forb-dominated wetland provides different aspects of habitat for elk than a stand of lodgepole pine; a forested riparian corridor has a different effect on a stream than open vegetation.

**Origin** - the means by which landscape structure was created (e.g., fire, timber harvest, landslide, etc.). Origin is important in understanding landscape dynamics from the standpoint of rate of change, i.e., how likely is the event to occur again, and create additional patches of this type?

**Stability** - the likelihood a landscape structural element will change significantly (in composition, physical features, etc.) over time, and the rate of that change. For example, early successional patches are unstable (in Pacific Northwest forests, last 15 years or less) compared to old growth (may last for centuries). Landscape patterns dominated by unstable elements function quite differently from those with a greater degree of stability, and have a greater need for repeated disturbance to retain their character. For example, forest landscapes with a large component of early successional patches are generally more hospitable to wildlife species that use a variety of habitats than to those with a more narrow set of needs, because the habitat characteristics change through succession in a fairly short period of time. Productivity and the probability of disturbance are two major influences on stability of landscape elements.

The landscape pattern itself (the arrangement of landscape elements) can also be described in terms of its stability, which is basically a reflection of the combined stability of individual landscape elements, and their position relative to each other. For example, the outcome of a disturbance by fire is different in a landscape where fire-resistant (stable) patches are interspersed

among fire-susceptible (unstable) patches, vs. a pattern where all the fire-susceptible patches are aggregated in one or a few parts of the landscape.

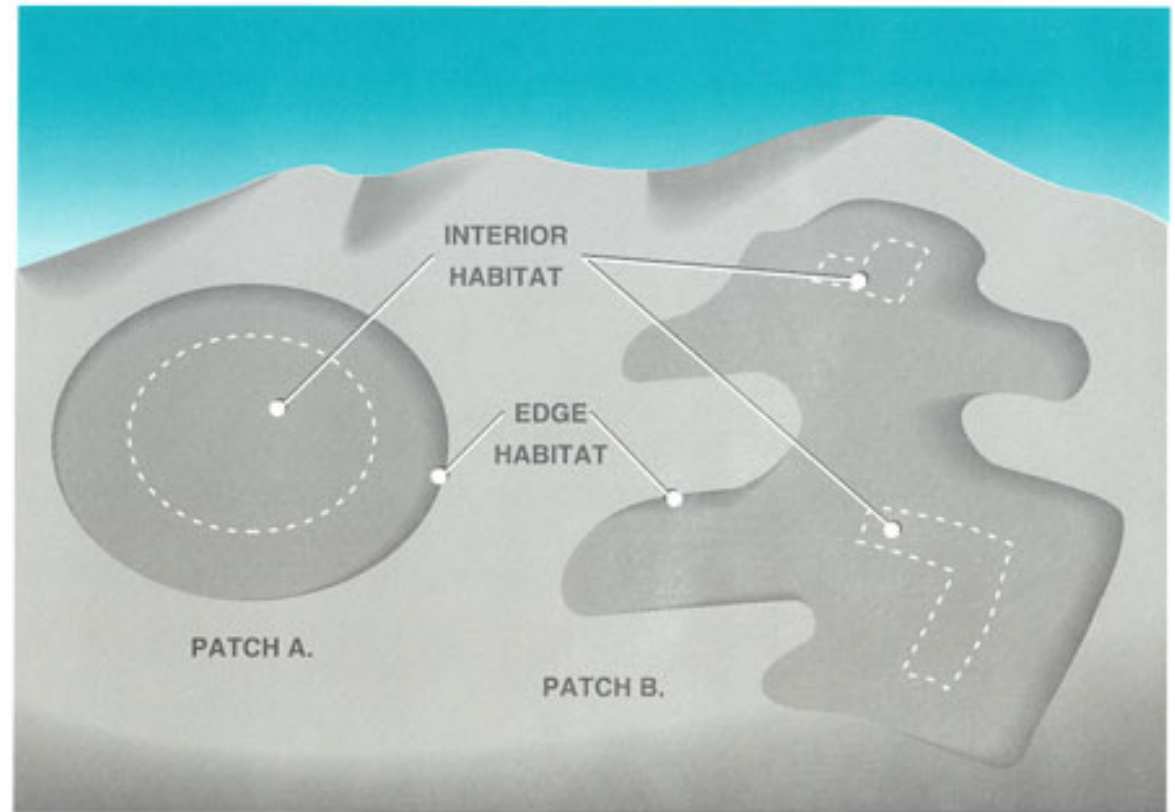
**Contrast** - the degree to which adjacent landscape elements differ from each other, with respect to species composition and physical attributes. For example, there is a high amount of contrast between a sedge/willow wetland and a mature conifer forest, in both the plant and animal species present, and in physical characteristics (low vegetation with graminoids and shrubs vs. large trees). Contrast exerts control over landscape dynamics to the extent that it affects landscape flows. For example, high-contrast landscapes with a large amount of edge (habitat on the interface of two contrasting patch types, that contains some characteristics of both) is suitable to some wildlife species, and not to others. Those species that are not suited will find it difficult to travel from one portion of the landscape to another, in seasonal migrations or to locate new habitat. Landscapes with low contrast (“landscapes without lines”) may still have diversity of patches, but the boundaries between patches will be less distinct, more “feathered”.

**Edge** - the interface between landscape elements of different composition and structure, for example between an open clearcut and a closed-canopy forest. Edges have environmental conditions (temperature, light, humidity, wind) that are different from either of the adjacent landscape elements. For plants, this often translates into combinations of species from both adjacent patch types. For animals, it is reflected in differential use of edges versus either adjacent patch type, or by the presence of species that prefer edges. Edges can be high or low contrast, depending on the similarity of the adjacent patches to each other. The degree of contrast of the edge determines how wide the edge is, or how deep into the adjacent patch the edge effects penetrate. In the Pacific Northwest, an average edge depth of 500 feet is commonly assumed for a forest/opening interface.

Some kinds of edges attract people. Preference is often for high contrast edges to frame distant views, and for natural-appearing open spaces. Understory vegetation and/or low-branched trees are also desirable in the edge for a sense of privacy, “nestling in” and screening out sights and sounds of other humans.

**Patch shape** - important because of the effect it has on the amount of edge and interior that exists. In other words, patches that are regular (more like a circle, square or rectangle) have

**Figure 3 - The effect of patch shape on amount of edge habitat. The more a patch tends to be circular, the greater the amount of interior habitat. Patch B actually has greater total habitat, but less interior habitat.**



less edge than irregular shapes. This is of particular importance to species that prefer interior quality (non-edge) mature forest habitat. In a landscape with irregular-shaped patches of forest, amount of interior habitat may be much less than it appears, due to amount of forest that actually functions as edge - see Figure 3. The shape of patches, and how they conform to underlying landforms is also a strong component in the aesthetic quality of a landscape. Patch shape can be quantified by the use of fractal dimensions, an index of the complexity of patch shape (relationship of perimeter to area).

**Grain** - the average size of landscape elements: the “texture” of the landscape. Fine-grained landscapes have numerous small patches, coarse-grained landscapes have fewer, larger patches.



Landscapes also differ in the variability of patch sizes. Often, human alteration of landscapes creates a pattern of smaller, more uniformly-sized patches (envision a checkerboard of 40- to 60-acre clearcuts with similarly-sized forested leave blocks). In contrast, natural landscapes tend to have a wider range of patch sizes.

**Patch size** is important for certain human experiences. Approximately 5000 acres of unmodified natural setting offers a high probability of experiencing a sense of vastness, isolation from the presence of other humans, independence, closeness to nature, tranquility and self-reliance. Patches less than 2500 acres offer a lower probability, but are important as places for semiprimitive experiences. Patch shape effects the perceived size as described above. Patch size is also an important habitat feature for some wildlife species.

**Connectivity** - the spatial contiguity within the landscape. It is a measure of how easy or difficult it is for organisms to move through the landscape without crossing habitat barriers. Connectivity occurs both within the matrix and via corridors. The degree of connectivity within a particular landscape depends on the organism being considered; e.g., species that require mature forest riparian corridors to travel will experience connectivity in a given landscape differently from species that can travel in a variety of types.

**Porosity** - the density of a particular type of patch within a matrix. Porous landscapes have many small patches of similar type contained within the matrix, which consequently has a high degree of edge. This condition has also been called fragmentation, and is of concern in Pacific Northwest forests because it reduces habitat with interior-forest qualities. Porosity does not necessarily reduce connectivity of the matrix, but it does affect matrix area and increases both the amount of edge and contrast.

**Patchiness** - the density of ALL types of patches within a landscape. It is similar in concept to porosity, but takes into consideration the diversity among patches. Patchy landscapes are those that have a large number of patches of different types.

**Heterogeneity** - the variation in aggregations of landscape elements across a landscape. A landscape is micro-heterogeneous if it has many different landscape elements (is patchy) per unit area. It is macro-heterogeneous if the combination of landscape elements in one part of the landscape differs significantly from the combination in another part.

### Landscape Functions

It was asserted above that ecosystems consist of structures that perform a number of functions (capture, production, cycling, storage and output). That being the case, the task now is to examine how the structures of landscapes (patches, corridors, the matrix, the pattern) carry out these various functions.

The key to understanding ecological functions at the landscape level is the concept of landscape flow. Certain ecological phenomena move across or interact with landscapes, or otherwise operate at a landscape level. Some examples are: wildlife species that migrate beyond individual stands or small patches, humans, fire, wind, grazing animals, and water. Any one of these landscape flow phenomena will have a specific way of interacting with both a given landscape element AND the landscape pattern in aggregate; it is this interaction that provides insight into how the landscape functions as an ecological system.

Some examples: early successional patches with a high degree of forb cover (the landscape element) provide elk (the landscape flow) forage (function: production); wetlands (the landscape element) provide water flow (the landscape flow) regulation (functions: cycling, storage); roads (the landscape element) leading into an area provide people (the landscape flow) with access to recreation sites (functions: capture, cycling, output); a fragmented forest landscape pattern (the aggregate of elements) provides deer (the landscape flow) with winter range forage and cover (functions: production, storage). And so on.

Understanding landscapes as ecological systems is an interdisciplinary exercise. Landscape flows of ALL types are important in characterizing the functional relationships within landscapes. A landscape analysis that ignores any of the major flow phenomena, or fails to synthesize the relationships among them, is incomplete.

### Landscape Resilience and Diversity

If the premise that ecosystem resilience derives in part from diversity is accepted, the next task is to characterize elements of a diverse landscape.

Diversity has been characterized as having three components: compositional, structural and process (also termed “functional”; “process” is used here to avoid confusion with the concept of ecosystem function). Compositional diversity at the landscape level refers to the variation in types of landscape elements or vegetation types, their relative proportions within the landscape, their degree of rarity or

commonness. Structural diversity describes the variation in sizes and shapes of landscape elements, as well as diversity of pattern (heterogeneity) (Noss, 1990). Finally, process diversity relates to the variety of landscape flows, functions and processes present. All three types are thought to be important in sustaining resilient landscapes in the Pacific Northwest.

What, then, constitutes a diverse, resilient landscape? It is a difficult question to answer, partly because the answer varies so much from one landscape to another. The other problem inherent in the question is that it lacks an objective reference point: what level or amount of diversity are we attempting to achieve? The answer to THAT question involves values and speculation to a high degree.

Regardless, there are still some generalizations that probably can be made about diversity objectives for Pacific Northwest forest landscapes. At the optimum, there should probably be:

- 1) A variety of patch sizes, shapes and types that includes elements of the pattern (proportion, frequency and arrangement on the landforms) which would have resulted from natural disturbance.
- 2) Where appropriate, nodes or patches of interior-quality late successional forest, networked by connections through corridors or through the matrix.
- 3) Protection of rare, unique or diversity-enhancing landscape elements (e.g., rare plant populations, wetlands).
- 4) Where feasible, disturbance (change-creating) processes such as fire, wind, insects and pathogens having a role in the evolution of the landscape pattern through time.

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*The references listed in this section were useful to the authors in preparing this publication. They do not represent a comprehensive list of readings in the subject of landscape ecology, analysis and design. Journals like Landscape Ecology (SPB Academic Publishing, The Hague) and Conservation Biology are excellent sources for further reading.*

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CHAPTER 3

# Landscape Analysis/Design and Land Management Planning Processes



WHAT IS THE  
APPROPRIATE SCALE?

WHERE DOES LANDSCAPE  
ANALYSIS AND DESIGN FIT?

INFLUENCES ON DEVELOPMENT  
OF PROPOSED COURSES OF ACTION:  
TOP DOWN/OUTSIDE IN AND  
BOTTOM UP/INSIDE OUT

ROLES OF INTERDISCIPLINARY MEMBERS  
IN LANDSCAPE ANALYSIS AND DESIGN



It is not the intent here to prescribe where and when landscape analysis and design should take place in relation to various National Forest planning processes. There are, however, some features that fit well with certain aspects of existing planning activities, and this Chapter will point them out. There are two questions to address, one relating to the scale of the area being considered, and the other relating to the point in a process at which it makes sense to do landscape analysis and design, relative to other steps.

Because the concept of a landscape has been quite loosely defined (see Chapter 2), landscape analysis and design can be applied to areas of varying size. In the Pacific Northwest Region, planning/design/evaluation of land management activities is organized into three scales: 1) a National Forest, 2) an Integrated Resource Analysis Area (Analysis Area = an area roughly the size of major drainage or subdrainage where a number of different projects might occur; analogous to “Project Areas” or “Opportunity Areas” in other Regions), and 3) an individual project area (for example, a timber sale). Figure 4 illustrates the flow of planning and implementation from the largest scale (National Forest - Forest Plans) to the smallest (individual project), with feedback built in that allows for adjustments to occur.

One goal of the Landscape Analysis and Design Process is to provide a means for tailoring the rather general direction (regarding landscape pattern) from Forest Plans to accommodate local conditions and resource issues. The most logical place to apply the Process then becomes the level of the Integrated Resource Analysis, since it provides continuity between the larger and smaller scales. With sufficient information and time, the Process could also be carried out for an entire National Forest. However, application will have the fewest frustrations and greatest benefits when applied to areas similar to Analysis Areas, roughly between 5000 and 50000 acres in size.

## WHAT IS THE APPROPRIATE SCALE?

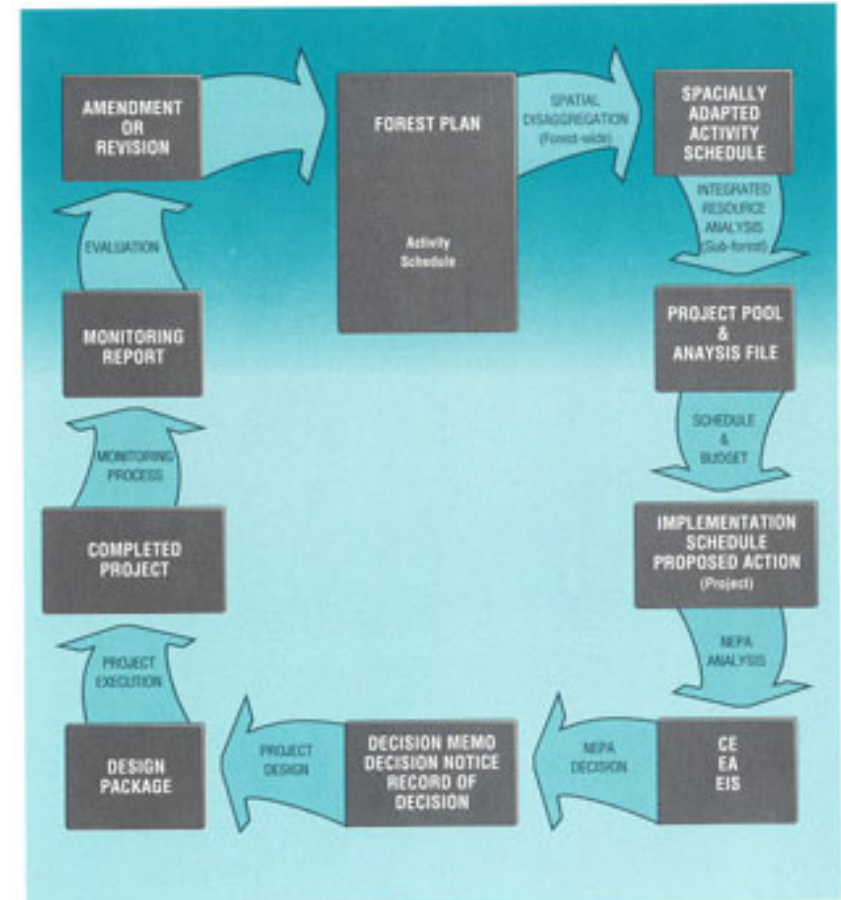


Figure 4 - Flow Chart of Forest Plan Implementation. Reproduced from: USDA Forest Service Pacific Northwest Region, 1990. “Steps of the Journey (Forest Plan Implementation Strategy)” p1-5.

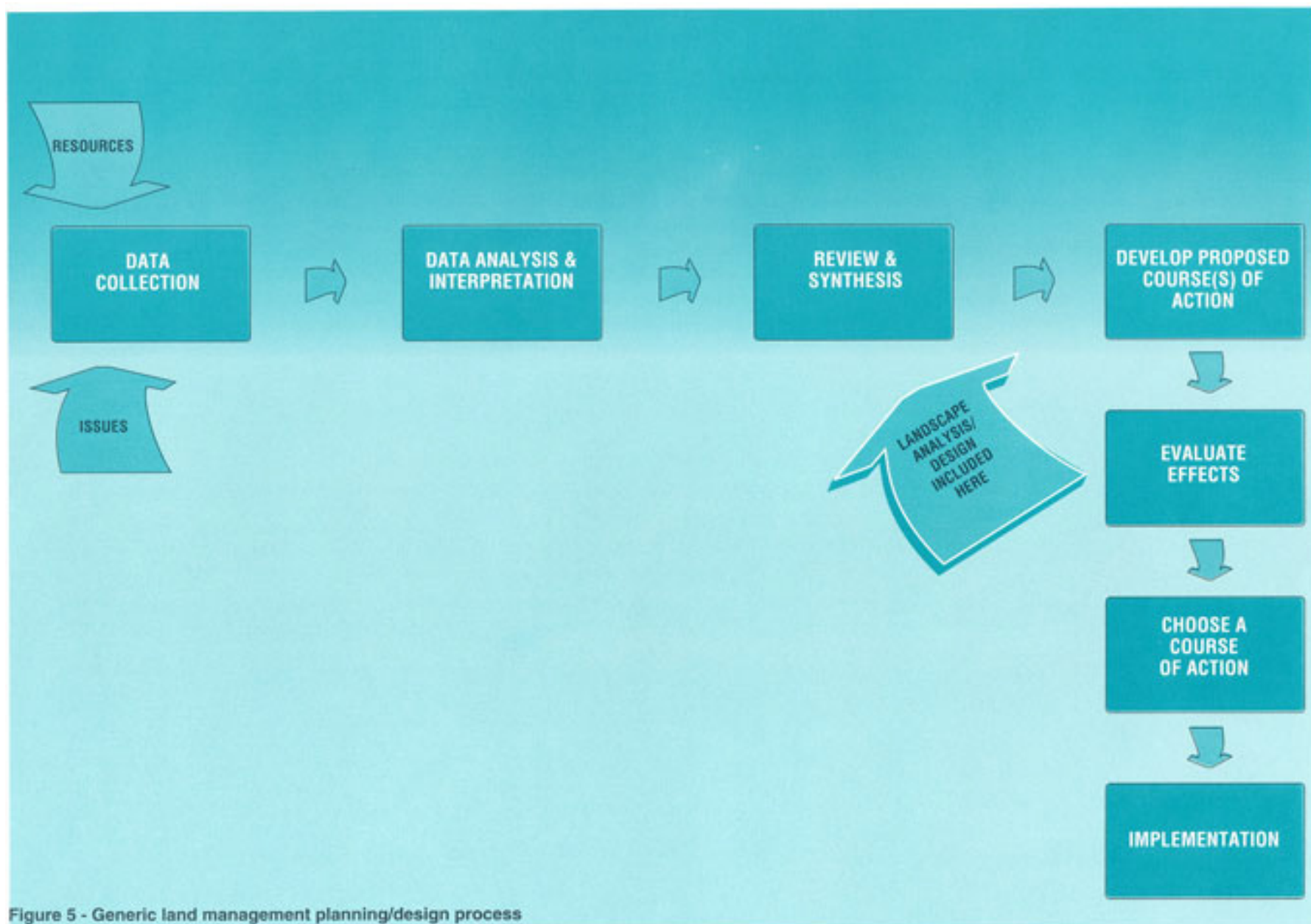
## WHERE DOES THE LANDSCAPE ANALYSIS AND DESIGN PROCESS FIT?

Planning/analysis/design processes vary widely among Regions, National Forests and Ranger Districts. Even within a single Ranger District, application of process varies between Analysis Areas, depending on many factors. But amidst all this diversity, there is a somewhat generic sequence of steps that is common to all, shown in Figure 5. In the first step, information is gathered about resources and about public expectations for an area; often this is called inventory or data collection, and scoping. At this step, some objectives for the area are already apparent, having been passed down from the next higher level of planning (Forest Plan Direction). The next step is data analysis and interpretation. Usually these first two steps take place in a “multidisciplinary” fashion, with a number of different resource specialists operating relatively independently of each other.

In the third step, the individual specialists come together in an “interdisciplinary” fashion to review and synthesize their information, melding their data and ideas, and identifying areas of conflict, overlapping interests, and so forth. Local objectives often are identified at this point, specific to the analysis area. The outcome of this synthesis process is generally some proposed course of action, or alternative courses of action. Then, the effects of the proposed actions are analyzed and described, with the results being compared to the objectives and used to evaluate the desirability of each alternative. Finally, a particular course of action is chosen, and implementation ensues. Since this generic process occurs at a number of scales, implementation at higher levels equates to starting the process over for the next lower level, and so on, until the project level is reached.

The most logical place to apply the Landscape Analysis and Design Process is at the review and synthesis step, when resource and public values information have been gathered. The target landscape pattern generated in Landscape Analysis and Design then has two uses later in the generic planning/analysis sequence: 1) to inform the development of proposed courses of action and 2) in the evaluation of effects of alternative actions.

In the Pacific Northwest Region, there are two basic ways the Landscape Analysis and Design Process has been used. One is in an Integrated Resource Analysis that does not involve NEPA documentation or alternative proposed courses of action. In this scenario, the target landscape is incorporated into the “Desired Future Condition” for the analysis area. When the NEPA process IS invoked, or when more than one proposed courses of action will be analyzed, the target landscape becomes an important “resource layer” used to derive and test alternatives.



## INFLUENCES ON DEVELOPMENT OF PROPOSED COURSES OF ACTION: TOP DOWN/OUTSIDE IN AND BOTTOM UP/INSIDE OUT

Another way of looking at how the Landscape Analysis and Design Process fits with current planning/analysis/design activities is to consider the various sources of influences over the results of such activities. These influences can be characterized as top down/outside in, or bottom up/inside out (Figure 6).

**Top down/outside in** influences are either passed down from a higher level of authority or are developed from sources outside the immediate analysis area. They are frequently stated as direction, goals, general objectives, issues, concerns and so forth. For a typical analysis area, top down/outside in influences include:

Forest Plan direction - Management Area direction, standards and guidelines, Desired Future Condition statements, etc.

Agency direction

Issues and concerns expressed by members of the public or other agencies

Usually these influences are taken into account from near the beginning of a planning/analysis/design process, and strongly shape the themes around which proposals for action develop.

**Bottom up/inside out** influences emerge from information gathered about the immediate analysis area, so they generally enter the planning/analysis/design process following data collection and interpretation. They are most often stated as opportunities or constraints related to particular resources, and are commonly arrayed on “resource layer” maps. Examples are:

Map of “sensitive” soils or unstable geologic areas

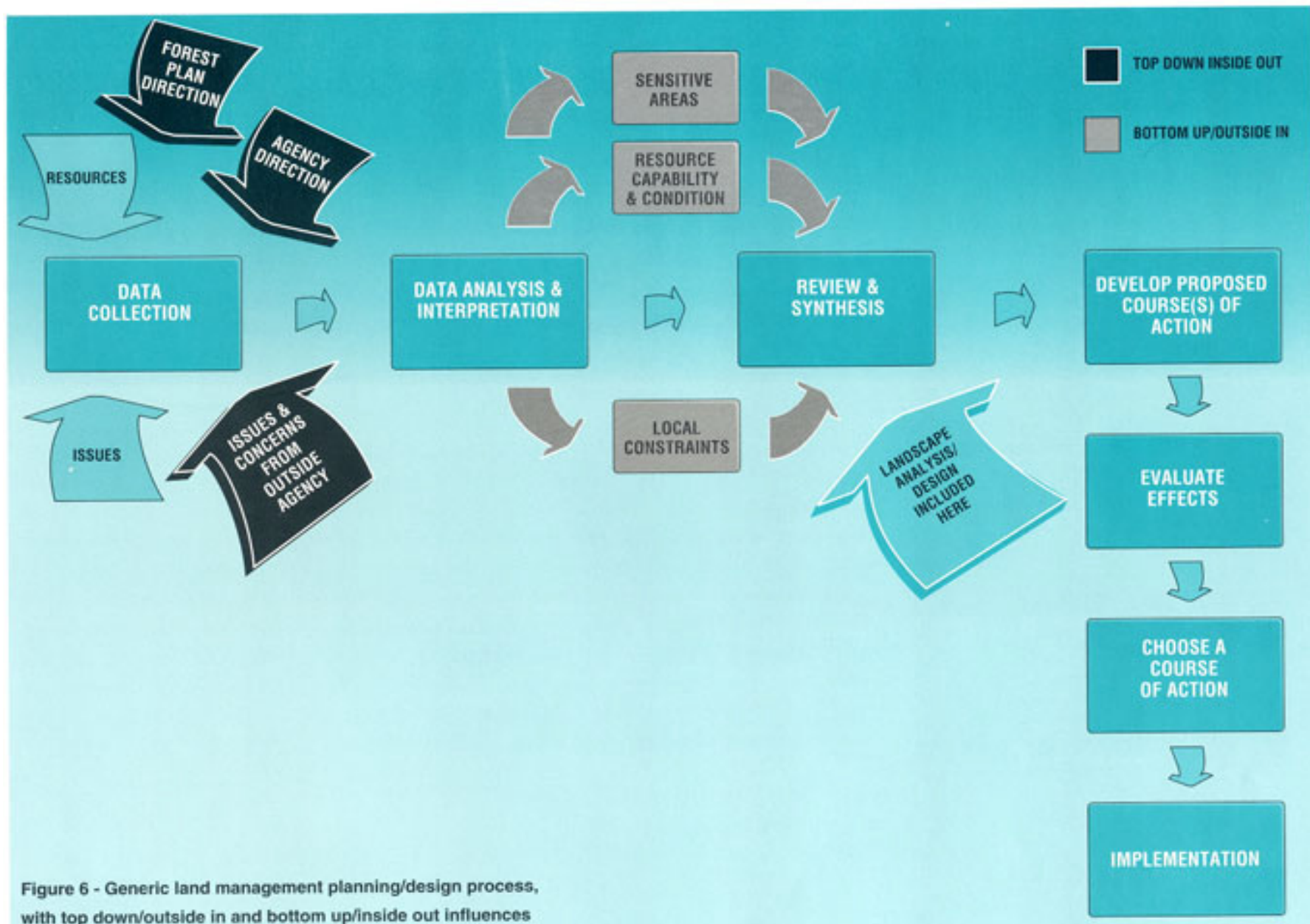
Map of activity setting and experience opportunities for various forms of recreation

Timber stand map, showing silvicultural priorities

Maps of locally important wildlife habitat areas

Some resource information combines elements of top down/outside in and bottom up/inside out influences, for example:





“Visual resource” maps that combine visual quality objectives with local features (includes existing as well as desired condition and character)

“Minimum Management Requirement” or big game winter range areas, which reflect local wildlife habitat conditions that have some degree of guidance from the Forest Plan or other direction.

The Landscape Analysis and Design Process is intended to help integrate these various sources of influence, at least with respect to the landscape pattern and function of the landscape ecosystem. In other words, it attempts to achieve integration at two levels:

- 1) Integration between top down/outside in and bottom up/inside out influences, by utilizing a combination of the Forest Plan direction, local issues/concerns/objectives and site-specific resource information to develop objectives about the future landscape pattern, and
- 2) Integration among individual resources, by using the resource-neutral concepts and language of the landscape ecosystem.

### **ROLES OF INTERDISCIPLINARY TEAM MEMBERS IN LANDSCAPE ANALYSIS AND DESIGN**

Commonly, resource specialists participating in a planning/analysis/design process are expected to play two roles, one as a source of knowledge and information about a particular resource area (multidisciplinary mode) and the other as a member of a team that must plan, analyze and design courses of action for an area (interdisciplinary mode). While it is not the intent here to completely define the contribution each type of resource specialist might make in the Landscape Analysis and Design Process, below are examples of some of the most important tasks, categorized by general resource. The focus here is on those items that enhance understanding of the landscape as an ecological system, and facilitate development of objectives regarding landscape patterns. The information below is intended only to exemplify what resource specialists COULD do in Landscape Analysis and Design, not to circumscribe or direct their activities. In individual teams, certain tasks might be accomplished by specialists with titles different from what is indicated here.

#### **MULTIDISCIPLINARY Botany/Plant Ecology**

Prepare vegetation maps, showing major vegetation types, potential natural vegetation, successional stages, etc.



Locate rare, unique and sensitive plants and plant communities

Develop information on rate and nature of succession in different vegetation types

Help describe effects of natural disturbances on vegetation patterns

### **Fire/fuels**

Develop information on fire history/behavior in the analysis area, and its effects on landscape patterns (past and future)

### **Fisheries/riparian**

Locate important riparian habitats and streams for fish production

Develop watershed-scale objectives regarding riparian habitat condition

### **Hydrology**

Develop information on water as a landscape flow phenomenon within the analysis area (surface and subsurface flows)

Locate areas within the landscape that are critical or at risk with respect to water quality

Develop information about the relation between different landscape patterns and the effects on water flow

### **Landscape Architect/Visual Quality**

Describe and map visual quality objectives within the analysis area (includes existing and desired visual condition and character)

Locate areas that are particularly sensitive or valuable as scenic resources Using landscape pattern objectives developed by the Team, prepare a spatial design of the target landscape pattern (this is a step of paramount importance in Landscape Analysis and Design, and is discussed in detail in Chapter 4, Step 8)

### **Recreation**

Develop information regarding people as a landscape flow within the analysis area; in other words, describe and map the interactions between people and the landscape, and the landscape structures important for providing various recreation settings, experiences and benefits

Locate opportunities to develop additional recreational resources, or reorganize existing opportunities, in terms of activities, settings and experiences

Describe and map Recreation Opportunity Spectrum objectives

### **Silviculture/Timber**

Help develop the vegetation map of the analysis area (see Botany)

Determine silvicultural objectives and strategies for stands

Once a target landscape pattern has been identified, develop the schedule of entries that would be required to perpetuate it

### **Soils**

Locate sensitive or critical soils within the analysis area

Provide information regarding the large-scale, cumulative impacts to soils of various management activities

### **Transportation/logging systems**

Develop information regarding the access/circulation pattern (existing and future opportunities)

Analyze the potential for use of various logging systems within the analysis area

### **Wildlife Biology**

Provide information regarding the use by wildlife species of various vegetation types within the planning area, including migration or movement patterns at the landscape level. Locate opportunities for enhancement of wildlife habitat

Locate rare, sensitive or at-risk wildlife populations or habitat

## INTERDISCIPLINARY

Once the landscape-level data from various resources has been acquired, it then becomes the responsibility of each Team member to assume an “interdisciplinary” role, in other words, to synthesize and integrate what has been gathered together. “Interdisciplinary” tasks of Landscape Analysis and Design include:

Melding the individual resource information into an understanding of the analysis area as an ecological system

Developing landscape pattern objectives that reflect the top down/outside in and bottom up/in-side out influences described above

Assisting in the development of the spatial design of the target landscape pattern



# CHAPTER 4

## Landscape Analysis and Design Process



INTRODUCTION

PROCESS SUMMARY

PROCESS STEPS AND EXAMPLES





## INTRODUCTION

In this section, a process for developing a target landscape pattern for an analysis area, based on the landscape ecosystem (structure/function) model, is described. When a new process is proposed, the impulse is sometimes to attempt to follow it to the letter, as though that would guarantee favorable results. The hope for THIS process is that readers will avoid that pitfall, and instead try to understand the essential intent and logic behind the steps, adapting them to their individual circumstances.

And this is that essential logic: 1) to understand the landscape as an ecological system, in terms of structure, function, processes and context within the larger landscape (Landscape Analysis - Steps 1 thru 5); 2) to identify existing policies regarding landscape pattern and objectives (Step 6); and 3) to combine knowledge of the landscape ecosystem, existing policies and local concerns to describe (Step 7) and spatially array (Step 8) the landscape pattern that individual projects will create.

This process is intended to facilitate determination of a landscape pattern within which both general Forest Plan and site-specific local objectives can be met. There are those who have questioned the need for such a description, preferring to simply to develop projects “consistent with the Forest Plan”, and avoiding inserting an additional “layer” of information (i.e., the pattern on the landscape) to consider. But... “If you don’t know where you’re going, any road will take you there.” Whether described *a priori* or not, land management activities WILL create a landscape pattern of some kind. It is important to consider whether that landscape pattern meets stated objectives, before the opportunity to adjust has passed.

The development of this process was shaped by a number of different perceived needs. The following were of paramount importance:

- To provide a means for integrating understanding of the local landscape with broad and sitespecific resource objectives into a “target” landscape pattern that could be used as a foundation for designing individual land management projects
- To blend with existing landscape-scale design processes (e.g., Integrated Resource Analysis)
- To utilize, where possible, skills and information that are commonly available to most Interdisciplinary Teams
- To minimize new jargon

- To focus on the landscape as an ecological system, thereby integrating resource concerns
- To allow public values and participation in generation of the target landscape pattern

In many respects, the existing Integrated Resource Analysis process DOES address objectives for particular landscapes, primarily for individual resources. In a sense, the Landscape Analysis and Design Process involves doing similar tasks, but with a different mindset, using different information, with a different focus, that leads to a more holistic view of the landscape as an ecological system. To achieve this, the following innovations have been incorporated into the Landscape Analysis and Design Process:

- Resources are integrated rather than considered separately at the design phase (they may or may not be considered separately in the analysis phase)
- The focus is on the landscape as an ecological system, emphasizing the relationship between structure and function
- Objectives (“Desired Future Conditions”) are stated in terms of landscape elements, functions and patterns, NOT as individual resource objectives (i.e., levels or kinds of uses)
- The existing condition of the landscape pattern does not necessarily circumscribe the “target” pattern

## PROCESS SUMMARY

Figure 7 illustrates the Landscape Analysis and Design Process. Steps 1 through 5 constitute the Analysis Phase, where information is gathered that is used to understand the character and function of the analysis area as a landscape ecosystem. Steps 6-8 make up the Design Phase, consisting of two distinct tasks: 1) describing objectives and 2) spatially arraying those objectives on the landscape. The 8 Steps of the Process are summarized below. In the following sections a more complete discussion of each Step is given, along with examples.



## ANALYSIS PHASE

**STEP 1 - Landscape Elements** - Identify, map and describe the elements of the landscape (patches, corridors, matrix), and the landscape pattern.

**STEP 2 - Landscape Flows** - Identify and map landscape flows of interest or concern.

**STEP 3 - Relation between Landscape Elements and Flows** - Describe the interaction between elements/pattern and flows, to facilitate understanding of the functional aspects of the landscape.

**STEP 4 - Natural Disturbances and Succession** - Describe how natural disturbances and successional process operate in the landscape, and how they affect and are affected by landscape pattern

**STEP 5 - Linkages** - Describe functional linkages to adjacent areas.

## DESIGN PHASE

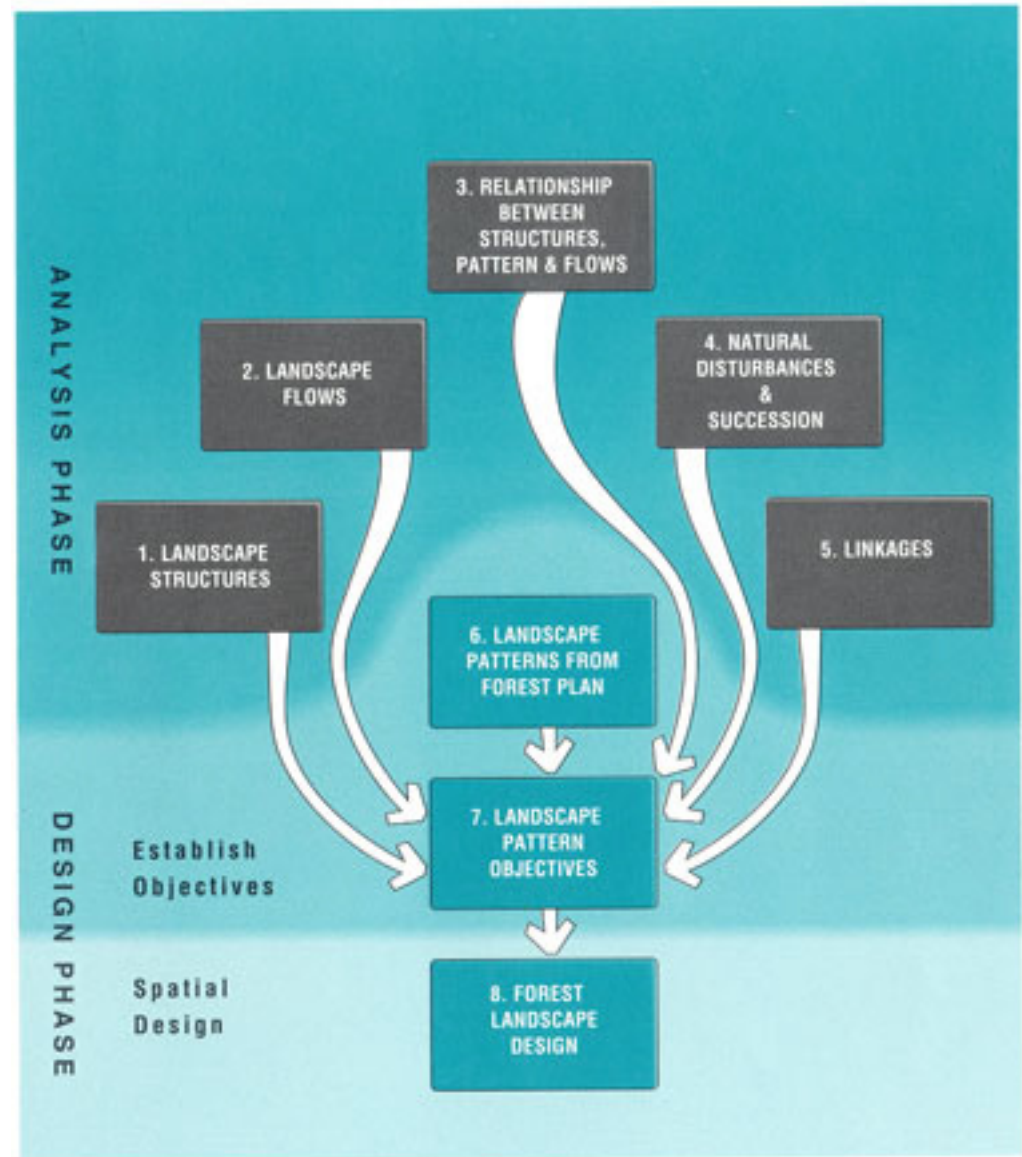
Establish objectives:

**STEP 6 - Landscape Patterns from the Forest Plan** - Determine what landscape pattern objectives already exist, from the Forest Plan.

**STEP 7 - Landscape Pattern Objectives (Narrative)** - Develop statements that describe the “target” landscape pattern (kinds, shapes, sizes, arrangement of landscape structures) in different parts of the planning area, using information from Steps 1-5 (Analysis Phase), Step 6, and local resource objectives specific to the analysis area.

Spatial design:

**STEP 8 Forest Landscape Design** - Using landform analysis and spatial design techniques, map the areas of the landscape within which a particular landscape pattern is desired, based on the objective statements from Step 7.



## LANDSCAPE ANALYSIS AND DESIGN PROCESS STEPS AND EXAMPLES

### INTRODUCTION TO LEOLAND

This section includes a detailed description of each step of the Landscape Analysis and Design Process, along with examples drawn from an analysis area on the Clackamas Ranger District, Mt. Hood National Forest. To streamline the example and make it more manageable to describe for this publication, a few liberties have been taken with reality. Where this is the case, it is noted in the text.

The example landscape, Leoland, is an analysis area of about 8800 acres (actually rather small for application of the Landscape Analysis and Design Process) along the Clackamas River on the west slope of the Cascades in Oregon (Figure 8). (It takes its name from Leo Yanez, the District steward responsible for all activities within the analysis area).

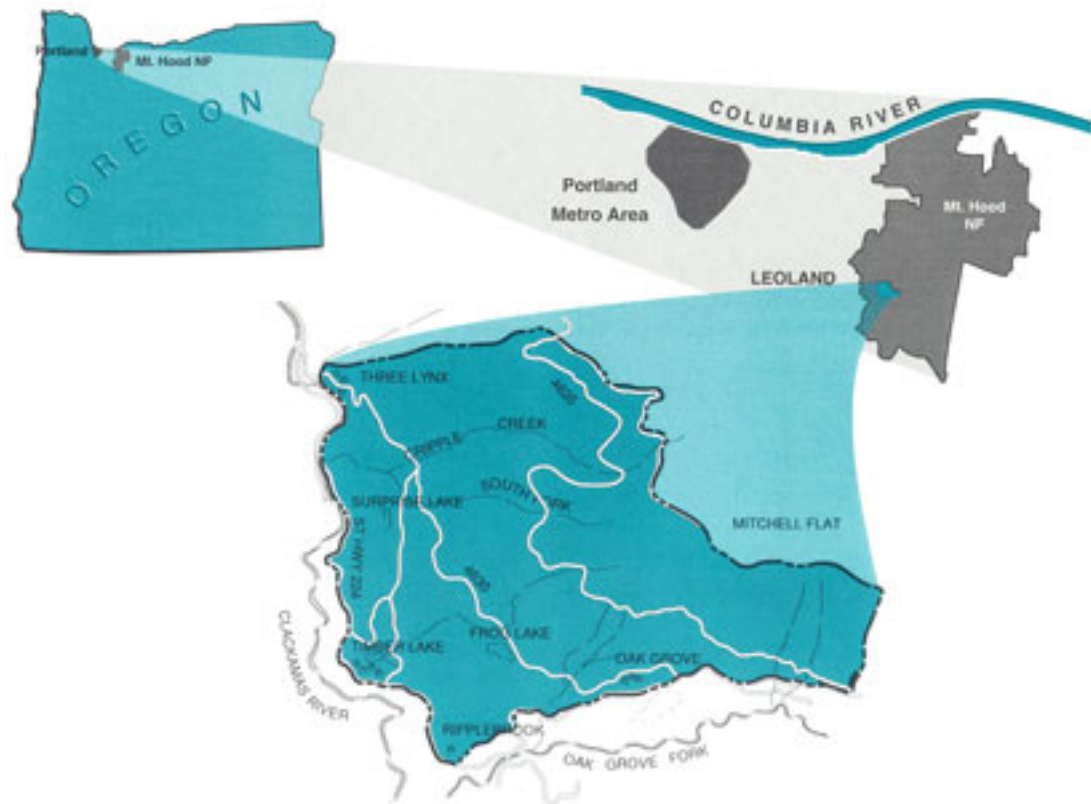


Figure 8 - Leoland Vicinity

The southern portion of Leoland is an old but still somewhat unstable earthflow, with complex, gently rolling topography and numerous wetlands and seeps. The landforms rise steeply to Mitchell Flat, a large plateau that extends north and east. Areas of outcropping rock are common on the steep midslopes, and the scarp of the earthflow is evident. In the northwestern corner of Leoland, Cripple Creek and its South Fork occupy steep-sided drainages.

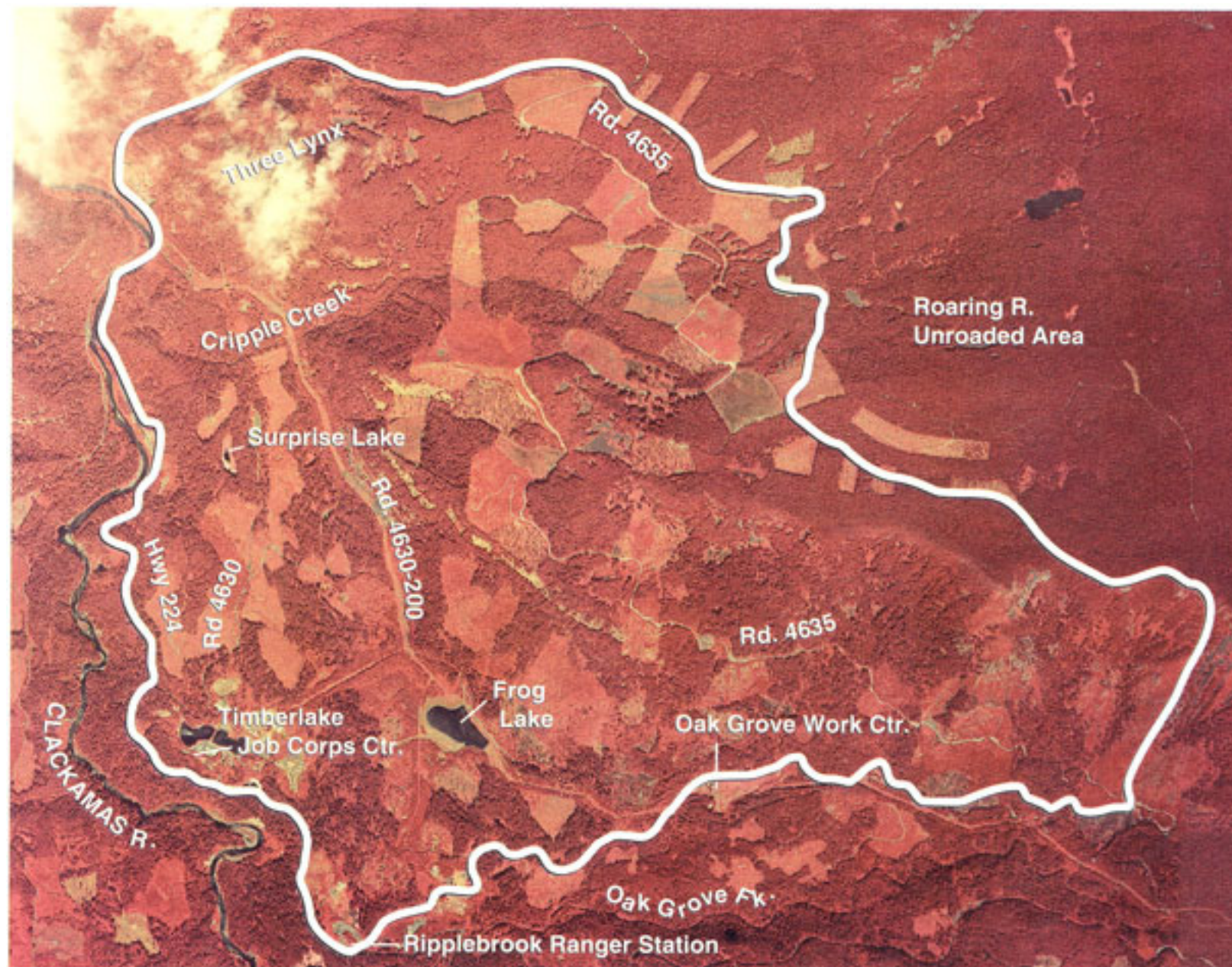
Figure 9 shows the present landscape pattern in Leoland, significantly affected by past timber harvest. Logging began in the late 1940's, at the end of World War I I, on the lower slopes near what is now Timber Lake Job Corps Center (formerly a mill site). Clearcutting subsequently moved upslope, with current active timber sales occurring in the Mitchell Flat area. A distinctive feature of Leoland seen from aerial photos is the pipeline that runs diagonally from southeast to northwest. The pipe carries water to a hydroelectric power generating facility at Three Lynx.

There are a number of human settlements in Leoland, including Ripplebrook Ranger Station and its residential compound, Oak Grove (additional Forest Service housing), Timber Lake Job Corps Center, and Three Lynx (associated with the hydroelectric power plant).

Due to ease of access from the Portland metropolitan area, Leoland is popular with recreationists. In particular, hunting, primitive camping and "driving in the woods" are common activities. Since the lower elevations of Leoland are important deer and elk winter range, hunting and wildlife viewing opportunities are abundant. The Clackamas River, which forms the western boundary of the planning area, is a designated Wild and Scenic River (Recreational Category). Oregon Hwy. 224 parallels the Clackamas River, providing access to the upper Clackamas drainage and Leoland.



Figure 9  
Leoland  
landscape



Since the relationship between structure and function is the keystone of understanding landscapes as ecological systems, identification of the landscape elements present and their arrangement is fundamental to getting started with any landscape analysis/design project.

In previous sections, the structural units of landscapes were described as patches, corridors and the matrix. So this step primarily involves defining and mapping those elements. In addition, the arrangement or pattern of elements, particularly of patches within the matrix, is described and analyzed.

**Detail and scale** - The first problem that arises is, what level of detail and scale should be used? A logical way to answer this question is to let the objectives of the analysis drive the degree of resolution. In other words, one can look ahead to the landscape flows or functions these landscape elements will be evaluated against and choose a level of detail that makes analysis of relationships possible. It is probably not necessary to distinguish between two similar, but not identical, patches if they contribute in the same way to landscape function. For example, a mature forest patch with the Western hemlock/Swordfern-Oxalis plant association and another with the Western hemlock/Vanilla leaf association differ floristically somewhat, but at the landscape scale probably have similar functions. In general, areas of vegetation that are discernible from aerial photographs commonly used in resource work (1:12000) make logical landscape patches.

It helps to view the process of delineating landscape structures as one of identifying areas that are homogeneous with respect to the following characteristics:

Plant community or ecosystem type

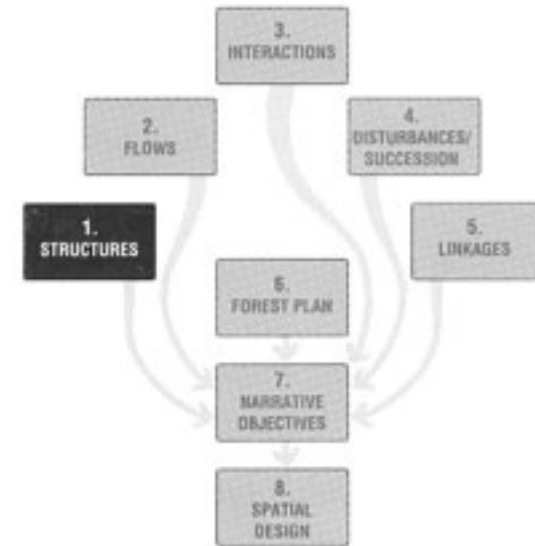
Stage of succession, stability

Within-patch structure

Ecological capability, productivity

Other patch attributes, such as origin, likelihood of repeated disturbance, or “naturalness” may also be included.

## STEP 1 LANDSCAPE ELEMENTS



## STEP 1 EXAMPLE LANDSCAPE ELEMENTS IN LEOLAND

The following illustrations and text describe the structural elements that occur in the Leoland landscape.

### MATRIX

Based on the criteria of relative area, connectedness and control over landscape dynamics (Forman and Godron, 1986), the matrix of the Leoland landscape is defined as “mature forest”, a combination of small and large sawtimber (Figure 10).

Composition of the mature forest matrix varies from one part of the landscape to another, especially on an elevational gradient. For this reason, the general matrix is subdivided into mapping units based on major ecological zone and stand structural class.

**Ecological Zones** - The following ecological zones occur in Leoland: Western Hemlock Zone (Halverson and others, 1986), Pacific Silver Fir Zone (Hemstrom and others, 1982) and Mountain Hemlock Zone. These are zones in the sense of Daubenmire (1968), areas of the landscape where a particular tree species is projected to dominate stands in a theoretical climax condition. In Leoland, they represent major differences in ecological factors such as growing season length, snow accumulation, forest community composition, productivity (in particular, the maximum size attained by mature trees) and wildlife use patterns.

Within each zone the following plant associations (projected climax plant communities) occur in Leoland. Separate mapping units were not made out of individual plant associations or groups of associations; delineation along zone boundaries seemed to provide sufficient detail for this analysis.

*(Note: in all of the ecological zones listed below, Douglas-fir is a dominant overstory species, increasingly so at lower elevations. Since Douglas-fir is successional to western hemlock, Pacific silver fir and mountain hemlock, it is not included in the names of the zones. Scientific and common names of all species are included in the Appendix.)*

#### Western Hemlock Zone

- W. hemlock/Vine maple-vanillaleaf
- W. hemlock/Vanillaleaf
- W. hemlock/Dwarf Oregongrape/Swordfern
- W. hemlock/Swordfern
- W. hemlock/Swordfern-oxalis
- W. hemlock/Rhododendron-Dwarf Oregongrape
- W. hemlock/Dwarf Oregongrape-Salal



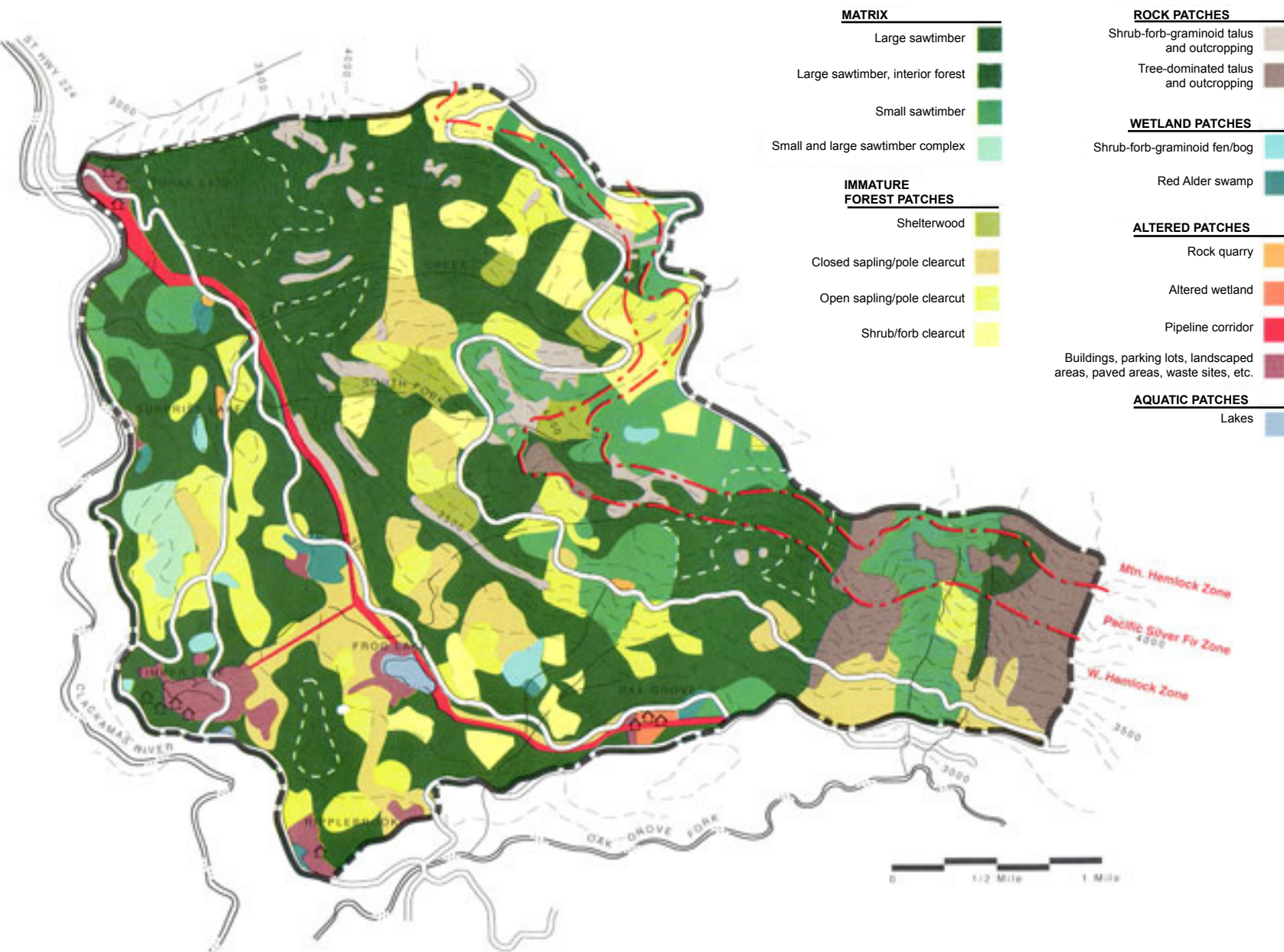


Figure 10 - Leoland landscape structures



Large Sawtimber



Small Sawtimber

### Pacific Silver Fir Zone

Pacific silver fir/Big huckleberry/Beargrass

Pacific silver fir/Rhododendron/Beargrass

### Mountain Hemlock Zone

Mountain hemlock/Big huckleberry/Beargrass

Mountain hem lock/Rhododendron/Beargrass

**Structural Classes** - Structural classes follow the terminology of Hall and others (1985) with some modifications. The categories that constitute the matrix are:

**Large sawtimber** - Mature forests with an average stand diameter  $>21$  ". Trees are usually  $>100'$  tall. The canopy frequently has openings, allowing development of a diverse understory. Varying amounts of snags and logs may be present. This category includes both old growth and late successional stands (generally 80 to 300+ years old). They are relatively stables, with an expected duration of one or more centuries.

**Small sawtimber** - Hall and others (1985) combined this condition with another (closed sapling/pole), but we chose to retain it as a separate type due to significant differences in canopy conditions, tree heights and understory characteristics. Small sawtimber stands have an average diameter of overstory trees between 11 " and 21 ". The canopy is often open enough to allow development of an understory, although it is not usually as rich or prominent as in large sawtimber patches. Tree heights range from about 50' to  $>100'$  tall, with more variation in height than would be the case in the closed sapling/pole type. Small sawtimber reflects two distinct conditions in Leoland: 1) "middle-aged" stands in productive sites, where they are expected to transition to large sawtimber within 30 to 50 years, and 2) late successional and old growth stands in poorer sites, which are quite stable and have a life expectancy of centuries.

1. In this discussion of mapping units, the term "stability" refers to the likelihood of the structure or composition of a type changing through natural succession. Thus, stable mapping units are those structural features and plant communities would remain relatively constant in the absence of a major disturbance. This does not imply that NO change will occur, but rather that the changes that DO occur will not lead to dramatic differences in the overall characteristics of the type.

To this framework of structural classes were added two additional mapping units: complexes of large and small sawtimber, and stands with interior, or non-edge, habitat. The latter are stands with a buffer of at least 500' on all sides. The 500' width is a convention; the actual width of a functional edge varies due to many factors. Small and large sawtimber complexes appear to be the result of "patchy" disturbances - a combination of low intensity fires and diseases - as well as fine-grained topographic factors (seeps, rock outcroppings, etc.).



**Matrix patterns** - Modification of the matrix through clearcutting and roadbuilding has been in progress in Leoland for roughly 45 years. The earliest areas to be affected were in the southwestern half, where a pattern of large, irregular-shaped openings connected by a dense network of roads was created (see Figure 9 and Figure 10). In later years, timber harvesting moved into the upper elevation forests in the northeast half of Leoland. Because logging practices had changed, the pattern created was different, with smaller, more regular-shaped openings connected by fewer access roads. As a result, both portions of the matrix are quite porous, but connectivity has remained greater in the upper-elevation northeast half of the landscape. On the other hand, the pattern (sizes, shapes and arrangement of patches) of the landscape in the west and southwest half is probably closer to a “natural” pattern that might have resulted from wildfire, i.e., “edgy” and irregular.

An interesting feature of the forest matrix is that its boundaries are relatively dynamic. That is, most (but not all) of the non-matrix patches within it are actually earlier successional stages that will ultimately take on the characteristics of the matrix. From a management perspective this is useful because of the flexibility in matrix manipulation it allows. In other words, opportunities exist to enhance or change the degree of porosity and connectedness to meet specific objectives, through regulating the pattern of harvested areas.

## PATCHES

Non-matrix patch types are also shown in Figure 10. They are: immature forest (of varying ecological zones, structural classes and successional stages), rock-dominated patches, wetlands, areas of semi-permanent alteration due to human activities and lakes.

**IMMATURE FOREST PATCHES** - The delineation of immature forest patches followed the same criteria as for the matrix, that is, along boundaries of major ecological zones and structural classes. The ecological zones are the same as described in the preceding section for the matrix. The stand structure classes (Hall and others, 1985) for immature forest patches are:

**Closed sapling/pole** - Young stands, with an average stand diameter of <11”. The height of the canopy is generally <50’ and usually very uniform, although remnant individual large trees from the preceding stand are sometimes present. A significant characteristic of this condition is the dense canopy, and resulting sparse (or absent) understory. These stands are moderately stable, and transition into small sawtimber in roughly 20 to 40 years.



Closed Sapling/pole



Open Sapling/pole



Shrub/Forb



Shelterwood

**Open sapling/pole** - Early successional stands dominated by conifers >10' tall, but with <60% canopy cover. The open canopy can be either a reflection of inadequate time to develop canopy closure, or site factors (such as impaired productivity due to soil disturbance or intense fire). Whatever the cause, a significant shrub component is usually present in this type. It is considered to be relatively unstable, transitioning into the closed sapling-pole type in 5 to 15 years in this area.

**Shrub/forb** - This classification combines two types from Hall and others (1985): the shrub type and the grass/forb type. They are grouped because in Leoland even the earliest successional stages generally include both shrubs and forbs. The species present are mostly pioneer species, with some representation of remnants from the previous stand. The duration of the shrub/forb stage in Leoland is about 10 years.

**Shelterwood** - This type is delineated as a separate patch although it does not fall within the classification system of Hall and others (1985). It is primarily a shrub/forb type with a component of residual mature (large or small sawtimber) trees, and thus combines characteristics of both the matrix and the non-matrix patch types.

**ROCK PATCHES** - Sites dominated by rock are of two forms in Leoland: 1) those where the vegetation is primarily shrubs, forbs and grasses; and 2) those with a substantial component of trees (both conifers and hardwoods), in addition to shrubs, forbs and grasses. In both types, mosses and lichens are important members of vegetative communities.

The rocky sites in Leoland are generally either talus boulder fields or outcropping basalt. Because the general orientation of the landscape faces south, these tend to be hot, dry sites that are sparsely vegetated. Rock-dominated patches are relatively stable with respect to plant community composition. Rock quarries are classified under “Altered Patches”.

**WETLAND PATCHES** - Two types of wetlands occur in Leoland: shrub-graminoid wet meadows and red alder swamps. A substantial portion of the wetland acreage has been disturbed, and in some areas reed canarygrass and other non-native species have replaced the natural communities (see “Altered Patches”). The undisturbed wetland plant communities are stable, as long as the water table is maintained.



Rock Patches



Wetland - Sedge/Willow



Wetland - Alder Swamp



Altered Patches

**ALTERED PATCHES** - Human activities have created several more or less permanent patch types in addition to those described above. These are grouped into the following categories: rock quarries, altered wetlands (where non-native species have replaced the original plant community), the pipe-line corridor, and developments (buildings, parking areas, waste sites, landscaping, hardened ground surfaces, etc.).



Aquatic Patches

**AQUATIC PATCHES** - Lakes were delineated as aquatic patches. Although there are both natural and man-made lakes in Leoland, we did not differentiate between them in this analysis.



## CORRIDORS

Figure 11 shows the locations of various types of corridors within the Leoland landscape. This corridor analysis departed somewhat from convention in that it included as corridors two landscape elements that do not have high contrast with the surrounding matrix: hiking trails and riparian forest corridors. This approach seemed justified by the functional importance of these relatively linear phenomena within the landscape, that of fostering transport of organisms (including humans) from one part of the landscape to another.

**Roads** - The major road corridors in Leoland are gravel-surfaced one-lane routes (with the exception of paved sections on the lower portions of Rds. 4630-200 and 4631) initially developed to provide logging access and (in the case of the 4630/4630-200 system) construction and maintenance for the pipeline between Harriet Lake and Three Lynx. These road corridors are relatively narrow, consisting of the roadbed itself and a narrow (generally less than 20' wide on either side) verge. The vegetation of the verge usually consists of a mixture of grasses, forbs and shrubs, some non-native. The most common species are: common brome, orchardgrass, bracken fern, Queen Anne's lace, swordfern, white hawkweed, fireweed, vine maple, willow, Scotch broom, trailing blackberry, bigleaf maple and red alder (scientific and common names of all species are cross-referenced in the Appendix).

**Trails** - Trails #702, #703 and #704 are recreational hiking trails that originate within the Leoland area. There is limited hiking opportunity within Leoland itself, confined primarily to trail #703 along the lower portion of Cripple Creek. Trails #702 and #704 provide access to unroaded recreation opportunities in the Cache Meadow/Salmon-Huckleberry Wilderness and Mitchell Flat areas, respectively; only the trailheads and short sections of the trails are within the boundary of Leoland. Trail corridors, except for the narrow tread itself, are indistinguishable vegetatively from the patch type in which they occur.

**Pipeline** - The Harriet Lake-Three Lynx pipeline consists of a large-diameter, half-buried pipe that traverses Leoland from southeast to northwest, carrying water to generate hydroelectric power at the Portland General Electric plant at Three Lynx. The pipeline corridor averages between about 30' to 50' wide, and consists of vegetation similar to that of roadside verges (see "Roads" corridor description, above). It is shown as a separate patch in Figure 10 because it is such a distinct feature of the Leoland landscape, and presumably affects movements of big game



Road Corridor



Trail Corridor



Pipeline Corridor

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Mature Forest/Riparian Corridor

animals in some areas. It generally has very high contrast with surrounding landscape elements, compositionally and structurally.

**Mature Forest/Riparian corridors** - Forested riparian corridors within Leoland are scarce, due both to the nature of the topography and the history of timber harvest. Cripple Creek and its South Fork are the major drainages. The South Fork lacks a well-defined forested corridor due to past timber harvest. The main stem of Cripple Creek is relatively forested along its length, and appears to provide connectivity (both with respect to water flow and mature forest habitat) between the late successional forests of the unroaded area to the north and east and that along the Clackamas River. There are significant breaks in the corridor where the pipeline, a clearcut and Rd. 4635 cross Cripple Creek, but there are as well substantial stretches where the mature forest is intact.

The corridor shown in Figure 11 along Cripple Creek was delineated somewhat arbitrarily to provide a width of 500' on either side of the stream, a minimum width thought to provide non-edge habitat within the corridor if the surrounding matrix were removed. It should be emphasized that the actual functional riparian corridor (zone of increased use for animal dispersal, zone of use by ripariandependent species, etc.) is not known precisely, but is presumed to be within the area delineated.

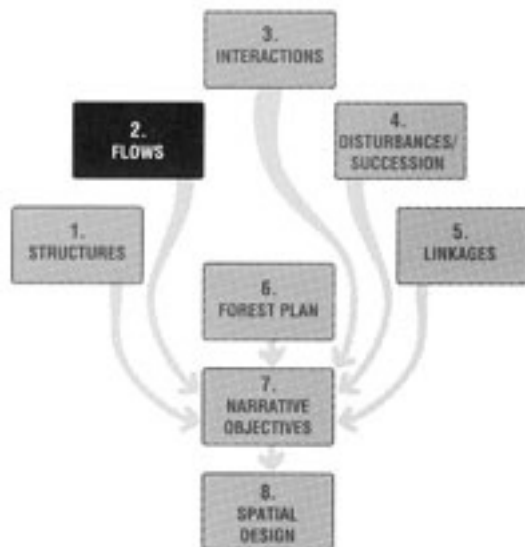
The vegetative aspect of the Cripple Creek corridor is similar to that of the forested patches that surround it - primarily Western Hemlock Zone late successional and old growth Douglas-fir forest. The floodplain is not sufficiently developed to have a distinct zone of riparian vegetation discernible from the landscape view. However, structural differences can be seen, with larger trees and a somewhat more diverse canopy near the stream.

There are two significant additional forested riparian corridors adjacent to Leoland that should be mentioned: one along the Clackamas River to the west and the other on the Oak Grove Fork of the Clackamas River to the south. Although both of these corridors have major roads within them, they are thought to provide connectivity among the mature forest stands within the highly fragmented larger landscape that contains Leoland. A small part of the Clackamas River forest corridor is actually within the boundaries of Leoland.



Figure 11 - Leoland landscape corridors

## STEP 2 LANDSCAPE FLOWS



The concept of landscape flows is discussed in Chapter 2. Flow phenomena are those things that move across or through landscapes, whether in the air, over land or in the soil (Forman and Godro 1986). They can be energy or material flows, expressed through living or non-living ecosystem components. Flows may be generalized over large sectors of the landscape, or confined to distinct corridors of a particular patch type or landform feature (e.g., stream corridors). The landscape flows of greatest pertinence to the Landscape Analysis/Design Process are water, wind, fire, animals (flying and ground-based), plants (particularly noxious weeds and non-native species) and humans (of various “user groups” - recreationists of different types, commercial users, etc.).

Some have argued about the appropriateness of including humans as a landscape flow in this analysis, asserting that humans are not a natural part of the landscape. But the fact is, people ARE present within and surrounding National Forest and their effects, needs, desires and expectations cannot reasonably be ignored in the design of forest landscapes. The priority that those needs and desires should have relative to other landscape flows is a question of values, not science, and individual practitioners must struggle with that question in the context of their own situation. Step 4 of the Landscape Analysis and Design Process DOES consider the patterns and functional aspects of landscapes created via natural disturbance processes, apart from human activities.

It is probably not realistic or necessary to consider ALL the landscape flows in a particular application. Often prior knowledge of the analysis area, as well as information developed through public scoping, will help determine a few flow phenomena that are of greatest concern or interest. Confining the analysis to those items will increase efficiency. This step is not meant to simply be an inventory of landscape flow phenomena, but is really intended to lead to an understanding of the functional roles played by various landscape elements identified in Step 1. Later in Step 3 the interaction between landscape elements and flows will be analyzed; out of this analysis emerges the relationships between ecosystem structure and function. Since the Landscape Analysis and Design Process is intended to lead toward a pattern of landscape elements that fosters continued function of important landscape flows, two central questions are:

In the future, what flow phenomena will be critical in this landscape?

Which flow phenomena are most likely to be affected by human activities? Some may not be seriously affected by changes in landscape pattern and are thus not as critical to the analysis.



The next phase of this Step is to describe in spatial terms (on a map if possible) how the landscape flows are occurring. The following questions should be addressed:

Where in the landscape does a particular flow occur? Is it dependent on a particular landscape element (matrix, corridor or network)?

What is the direction of the flow?

What is the timing (e.g., is it seasonal)?

Four landscape flow phenomena are demonstrated in this Step, based on what seemed to be of greatest public concern and most likely to be affected by management activities: elk, deer, humans and water. Mountain lions were considered as an addition to the list, as there have been several sightings in Leoland, and they are known to occur in the unroaded areas to the north. It was concluded, however, that because of the intensity of human activities in the area, as well as the number of roads, use of Leoland by mountain lions is probably peripheral. There are other species (notably river otter, beaver and bobcat) that are of interest as well, but that are ignored in this example to reduce complexity. A problem that emerged with wildlife information in general in this analysis, was a lack of data on migration patterns. In other words, there is abundant data on locations where individual animals have been sighted, but little on how they get from one place to another, or on their tolerances of changes in landscape pattern. Ranger District biologists were helpful in making inferences about patterns of movement based on their knowledge of habitat use, and it would be helpful for future analyses if this dimension were more adequately addressed in wildlife monitoring. Landscape flows in Leoland are shown in Figure 12.

**Elk** - Elk are commonly sighted throughout Leoland, particularly at the lowest elevations. Most of the observations in the Mitchell flat area occur during the summer months, while those below occur at all times of the year. Elk use of wetlands and other openings in the winter range portion of Leoland is particularly intense. The juxtaposition of forage areas and thermal cover (mature forest) presents a particularly favorable habitat situation. It is believed that the elk from Mitchell Flat actually migrate east into the Shellrock Creek drainage during the winter. The elk present in the Leoland winter range are thought to migrate from the Oak Grove Fork drainage and the Clackamas River drainage to the south.

## STEP 2 LANDSCAPE FLOWS IN LEOLAND

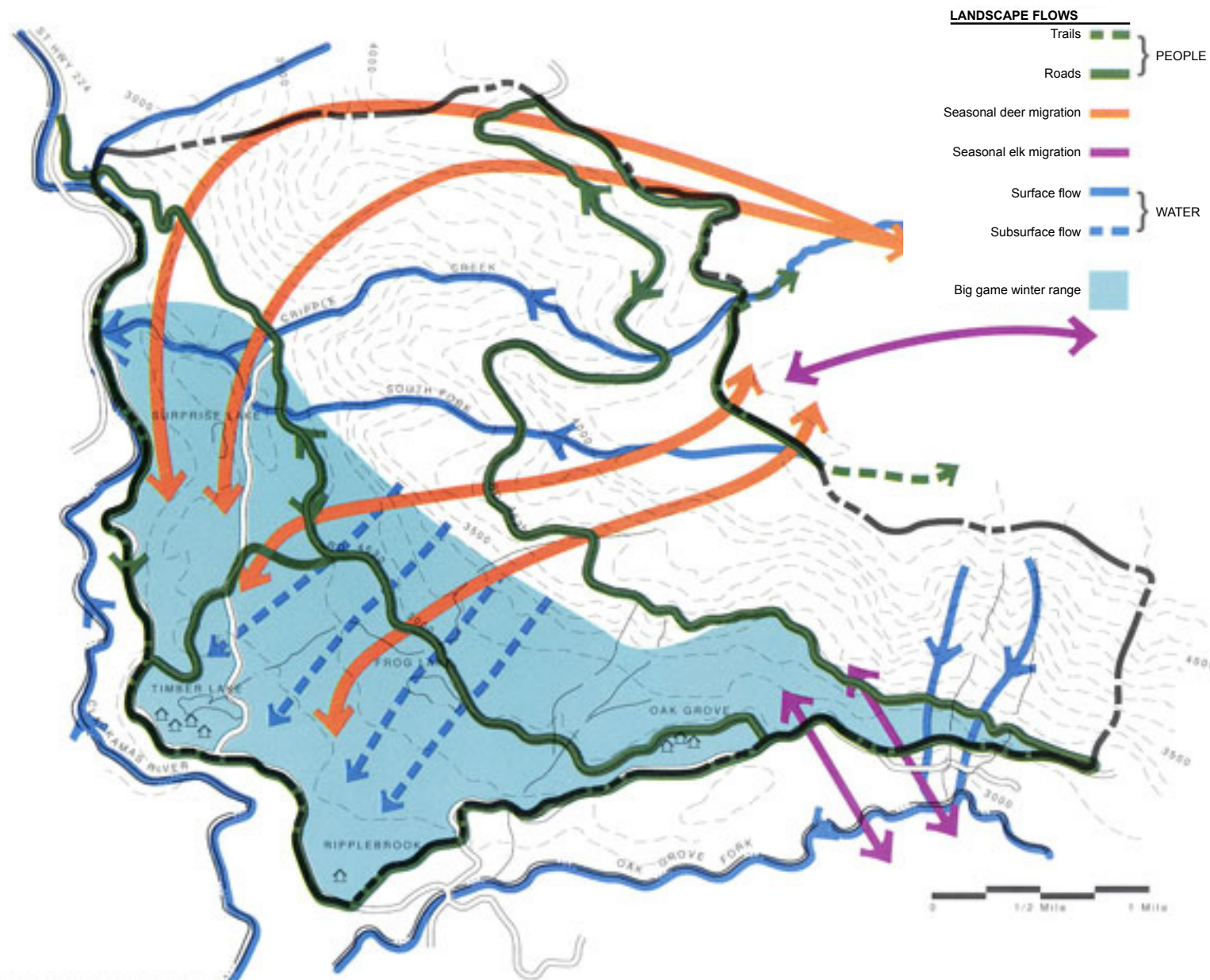


Figure 12 - Leoland landscape flows

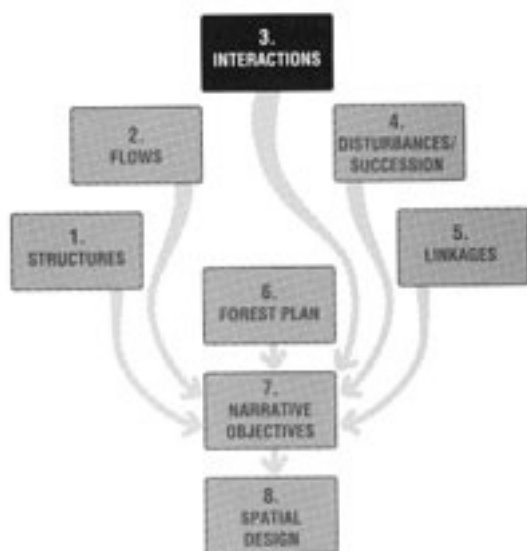
**Deer** - Deer are also abundant in Leoland. Both good forage and cover are found throughout the area, with many favorable shrub species occurring in older clearcuts, rock outcroppings and other openings. Like elk, deer exhibit intense winter use in the lower elevations of Leoland, due to the diverse pattern of openings and closed forest. It is believed that that deer migrate between the higher elevation summer range (Mitchell Flat and unroaded areas to the north) and winter range using major ridges in the vicinity of Cripple Creek as travel-ways. The pipeline that traverses the area is thought to be a barrier to this seasonal migration, and creating “bridges” for increased crossing opportunities has been considered.

**Water** - Water was chosen for analysis as a landscape flow in this exercise because of its role in the earthflow portion of Leoland. It controls the pattern of wetlands within the forest matrix, and influences earth movement in unstable areas. Upper elevation areas (above about 3600') have a more or less winter-long snowpack. Below this, the snowpack is subject to melting during periods of winter warming. When this condition is combined with heavy rain, the water table of the earthflow area is at its maximum and land movement is most likely to occur. This situation is exacerbated by increases in hydrologically “open” (i.e., areas without closed canopy forest) patches in the landscape.

**People** - Leoland has an important human component, due both to the actual presence of people and the effects of their activities. There are settlements at Ripplebrook, Timber Lake Job Corps Center, Three Lynx and Oak Grove. Recreation activities are primarily dispersed camping, hunting, huckleberry picking, target shooting and viewing. The area also provides access to unroaded recreation/backcountry recreation opportunities to the north and east. Because of its proximity to the Portland metropolitan area and ease of access, Leoland experiences some degree of illegal activities, notably illegal hunting. The dense network of old spur roads in the low elevation part of the landscape somewhat facilitates these activities. Commercial timber harvest is currently quite limited in Leoland, due both to the Forest Plan land allocation and to extent of earlier harvesting. At this time, commercial thinning is probably more common than regeneration harvest. There are timber sales occurring north of Leoland along Rd. 4635, which results in significant log truck traffic along Rds. 4635, 4630 and 4631 during periods of log haul.

The landscape pattern in Leoland bears extensive evidence of past human activities. Clearcutting has created extensive stands of saplings/poles and shrub/forb openings (see Figure 10). The pattern in the

### STEP 3 RELATION BETWEEN LANDSCAPE STRUCTURES AND FLOWS



earthflow portion of the landscape (where harvesting occurred during and shortly after World War II) is one of large, irregularly-shaped openings, with almost no residual large trees or snags. As logging practices have changed with time, the pattern (found in the middle and upper elevations in Leoland) has become one of smaller, more square or rectangular openings within the forest matrix, containing variable amounts of residual trees and snags.

Rock quarries, roads, altered wetlands and the pipeline offer additional evidence of human use, past and present.

In the introduction to this Process, it was stated that the overall goal is to use the ecosystem model (structure/function) as the basis for designing and analyzing landscapes. In this Step, what that model is for a particular analysis area is defined. Specifically, this Step describes how the landscape elements (matrix, patches, corridors and pattern) mapped in Step 1 function relative to the landscape flows listed in Step 2.

The central question for this step is:

How do the individual landscape elements, as well as the landscape pattern, interact with (foster, inhibit, increase, direct, etc.) individual landscape flows?

Out of this grows an understanding of how the landscape functions as an ecological system. Sometimes it is useful to think in terms of the 5 basic categories of functions (capture, cycling, production, storage, output). For example, areas of habitat connectivity between adjacent landscapes perform capture, cycling and output functions; wetland landscape elements provide a storage function for water; and so forth. While such a framework helps systematize our thinking, it can also lead to unnecessary detail. It would be inefficient to slavishly analyze every last combination of landscape element and flow when such analysis does not appear to be yielding useful information. Keeping the ultimate objective (to describe how the landscape performs as a system) in mind is important.

A problem that arises here, as well as other places in this Process, is lack of information. Not only is empirical data about the relationships between flows and elements lacking, but even worse, understanding of some of the conceptual aspects is still rather rudimentary. For example, the issue of how connectivity occurs through corridors and the matrix for various groups of organisms is not well understood. However, it is important to use what IS known.

There are many different ways to display the results of this Step. In this example, a simple two-way matrix is used, with landscape elements on one axis and flows on the other. This approach may not work well if there are a large number of element types or flows. Sometimes maps or simple descriptive paragraphs may communicate the information better. Readers are encouraged to experiment with display techniques, always remembering the objective of this step is to describe the dynamics of and relationships within the landscape ecosystem.

Figure 13 summarizes the relationships between the landscape elements (matrix, corridors, patches; from the Step 1 analysis) in Leoland and the major flow phenomena described in Step 2. From this information, functional aspects of the Leoland landscape can begin to be inferred. For example, the matrix types (large and small sawtimber) provide important cover for big game animals, snow retention and snowmelt regulation, and certain human needs/desires (commercial products, recreation opportunities, scenery).

The landscape pattern itself, the arrangement of patches within the matrix, also affects the way landscape flows occur in Leoland. As has been mentioned earlier, the juxtaposition of forage openings (wetlands and shrub-dominated clearcuts) to mature forest (for cover) has made the lower elevation portions of Leoland excellent winter range. This edgy, high contrast landscape is desirable for deer and elk, and thus also for hunting, enhanced by the dense network of spur roads. At the same time, the degree of hydrologic “openness” has probably increased the rate and amount of runoff, and thus the risk of earthflow events.

The pattern of natural rock openings embedded within the forest matrix in the middle and upper elevations of Leoland has also created favorable habitat conditions for deer and elk. Numerous desirable shrub and forb species are found in these areas making them valuable for foraging, with the forests providing cover and connectivity between them.

In the upper elevations of Leoland, the pattern is one of a forest matrix with interspersed square or rectangular clearcuts. The predominance of the forest matrix probably fosters snowpack retention, slowing the influx of groundwater into the earthflow area during the spring. For humans, the visual impact of the pattern is one of unnatural shapes and straight lines, which is undesirable to some.

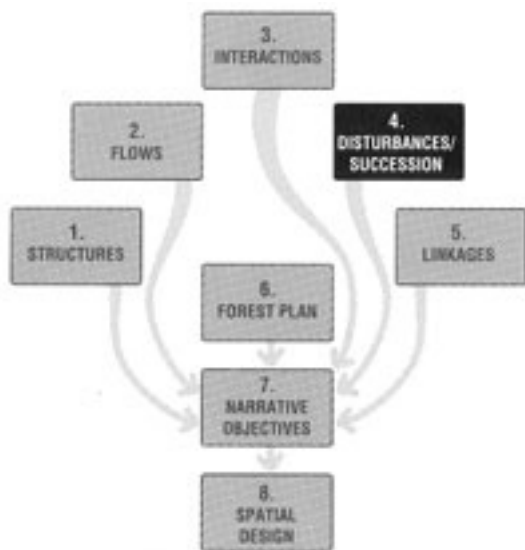
### **STEP 3 EXAMPLE LANDSCAPE ELEMENTS/FLOW INTERACTIONS IN LEOLAND**

LANDSCAPE ELEMENT <sup>†</sup>	LANDSCAPE FLOW			
	ELK	DEER	WATER	PEOPLE
<b>MATRIX</b>				
Large sawtimber (>21 “)	Optimal cover; important late/early season habitat; forage where canopy open	Same as elk	Snowpack retention in high elevs.; mitigates rain-on-snow in mid-elev.	Visually “forested”; hiking opportunities; commercial value
Small sawtimber (11 “-21 “)	Same as large sawtimber, fewer forage opportunities	Same as elk	Same as large sawtimber	Same as large sawtimber but not as valuable commercially or aesthetically
<b>IMMATURE FOREST PATCHES</b>				
Closed sapling/pole	Little value; possible thermal cover	Same as elk	Hydrologically “recovered” but lacks snowpack retention capability of large or small sawtimber	Visually an opening from a distance; little commercial or recreational value
Open sapling/pole	Small amount of forage present	Forage where shrubs present (mostly lower elevations)	Hydrologically “open”; earlier and faster snowmelt	Visually an opening; good hunting opportunities
Shrub/forb	Good natural forage at lower elevations, opportunity for enhancement at upper elevations	Same as elk	Same as open sapling/pole	Visually an opening, may enhance views of distant landscapes; hunting, poaching, huckleberry picking; good fall color; offensive to some
Shelterwood	Same as shrub/forb	Same as shrub/forb	Same as shrub/forb	Same as shrub/forb Natural visual and vegetative diversity; viewpoint opportunity; outstanding fall color
<b>ROCK PATCHES</b>				
	Some forage	Good forage, especially where shrubs are abundant; access may be limited	Rapid runoff	
<b>WETLAND PATCHES</b>				
Shrub/graminoid	Abundant forage, esp. in crucial winter range	Same as elk	Important storage, filtering; slows runoff in earthflow area	Visually attractive; wildlife viewing opportunities
Alder swamp	Abundant forage as well as cover	Same as elk	Same as shrub/graminoid	Same as shrub/graminoid

LANDSCAPE ELEMENT <sup>†</sup>	LANDSCAPE FLOW			
	ELK	DEER	WATER	PEOPLE
<b>ALTERED PATCHES</b>				
Rock quarry	Harassment	Harassment	Rapid runoff	Rock source; target shooting; visually offensive to some
Altered wetland	Forage; harassment	Forage; harassment	Storage/filtering functions may be affected	Visually open; target shooting, hunting; opportunity for restoration of natural vegetation
Pipeline route vegetation	Small amt. of forage; may impede migration	Same as elk	Little effect	Appears unnatural; water source for hydroelectric power plant
Developments	Harassment	Harassment	Rapid runoff	Variety of uses; appears unnatural
<b>CORRIDORS</b>				
Roads	Harassment when open, travel corridor if closed	Harassment when open, travel corridor if closed	Possibility of instability/washouts in earthflow area, esp. where steep	Major means of travel through the landscape
Trails	Little effect	Little effect	Little effect	Trails #702 and #704 provide dispersed rec. access to un-roaded areas. Opportunity to improve lower portion of Cripple Cr. trail to connect Mitchell Flat to Clack. R.
Pipeline . . . see entries for pipeline patch type, above				
Mature forest/riparian	Probably used as travel corridors	Same as elk	Protection of streambanks and stream; source of large woody debris for stream structure; runoff retention	Enhanced dispersed recreational opportunities

<sup>†</sup> See pp 4.8-4.17 for a more complete description of landscape elements in Leoland.

## STEP 4 NATURAL DISTURBANCES AND SUCCESSION



Without getting into a full discussion of the extent to which humans can or should dominate nature, it seems reasonable to propose that an understanding of natural processes, particularly large-scale disturbances and succession, should provide part of the background used to prescribe the landscape patterns that are created in National Forests. For many reasons, “naturalness” in National Forests has increasing value in American society today. That value is often expressed as concern with two very different manifestations of “naturalness”: biological diversity and aesthetics. Almost without exception, statements of objectives about these two topics include the term “natural”. Thus, in this attempt to understand landscapes as ecological systems, it is helpful to pose the following questions:

What agents of change at the landscape level would have existed in the natural ecosystem?

What would their effect have been on the landscape pattern (arrangement, composition, size and shape of patches; connectivity; characteristics of the matrix; etc.)?

How might natural landscape patterns have influenced the behavior of disturbance phenomena?

Answering these questions frames the possibilities of the landscape - what might be. It also helps define what “natural-appearing” means for a particular area, and what natural landscape-level diversity is. The underlying natural landscape patterns define the “spirit of the place”, the landscape character. Finally, through an understanding of the rate and nature of change, it tells how stable a particular configuration of landscape elements is likely to be. These are all extremely important aspects of interpreting and designing landscapes.

Disturbance and succession are really two facets of a single phenomenon: change. Disturbances are events that result in radical change in vegetative characteristics within the landscape, often in a very short time. Disturbances can be described in terms of their type, intensity, frequency, duration and effect. Fire, wind, insects and pathogens, and landslides seem to be the disturbance phenomena most useful for envisioning natural landscape patterns in the Western Cascades. The relative importance of each varies from one area to another; in the Landscape Analysis and Design Process, focusing only on those that are strong determinants of landscape pattern, and ignoring the others, is a practical approach.

Succession is simply natural replacement of vegetative communities, one by another, following an event that alters the original vegetation. Theoretically, the original vegetation is eventually restored



and remains relatively constant in composition until the next destructive event. But until that original state is regained, the vegetation is dynamic. It is useful to know how fast a patch type will change into something different, as well as what it will change into, because the functions (e.g., wildlife habitat, hydrologic function, visual appearance) of different communities varies significantly. Thus, the successional state of the patches in the landscape determines how well particular objectives will be met at a POINT in time; the successional process itself, played out across the landscape, determines how well those objectives will be met THROUGH time.

Again, the task in this Step is to understand how landscape patterns (the composition and arrangement of landscape elements) result from the action of change agents. Since most people are used to thinking of forest landscapes as relatively unchanging, it is tempting to take an erroneous detour at this point, and try to determine a single “historical” reference point in time for describing patterns created by disturbances. It must be emphasized that, since landscapes are dynamic, the pattern changes, sometimes radically, through time. (For example, in the Western Cascades the landscape pattern looks very different immediately after a major several-thousand-acre fire than it would 150 years later.) So, several reference points are often needed to obtain a complete picture of the interaction between disturbance phenomena and landscape pattern.

A frustration that may crop up in this Step is that information about disturbances and their effects on landscape patterns will generally be incomplete if it exists at all. This is particularly true in the Eastern United States where lack of evidence of natural vegetation communities and landscape patterns leaves much to conjecture. In the Pacific Northwest, historic records of fires or outbreaks of insects or pathogens can often be found. Maps of stand age classes are also helpful in interpreting historic fire patterns. Panoramic photographs that predate timber harvest are of significant value in getting a visual picture of natural landscape patterns.

Another question that sometimes arises is whether to include aboriginal humans as change agents, as in some areas native Americans used fire to create vegetative communities amenable to their hunting and foraging methods. Thus, the question is whether the definition of “natural” should include such disturbances. After considerable thought and debate on this subject, the authors have decided it is as much a philosophical question as it is an ecological one, and therefore leave it to individual practitioners to find a solution that fits their particular circumstances.

## STEP 4 EXAMPLE NATURAL DISTURBANCES AND SUCCESSION IN LEOLAND

Although a variety of natural forces of change have shaped the Leoland landscape, the two that to have dominated are fire and earthflow, creating the diverse pattern of patches of various kinds seen in Figures 14A-14C. Although Leoland is too far from the camera position in these photographs to see much detail, some valuable clues as to the effects of fire and earthflow are present.

Admittedly, these photographs represent a single point in time, and the landscape, especially in terms of structure and composition of individual patches, is dynamic. However, the pattern (sizes, shapes, arrangement) of patches shown is probably “typical” of what might be expected to occur at ANY point in time. In other words, out of all the possible landscape elements that might occur in Leoland, most of them are represented (or can be inferred), in a typical arrangement, in the photos.

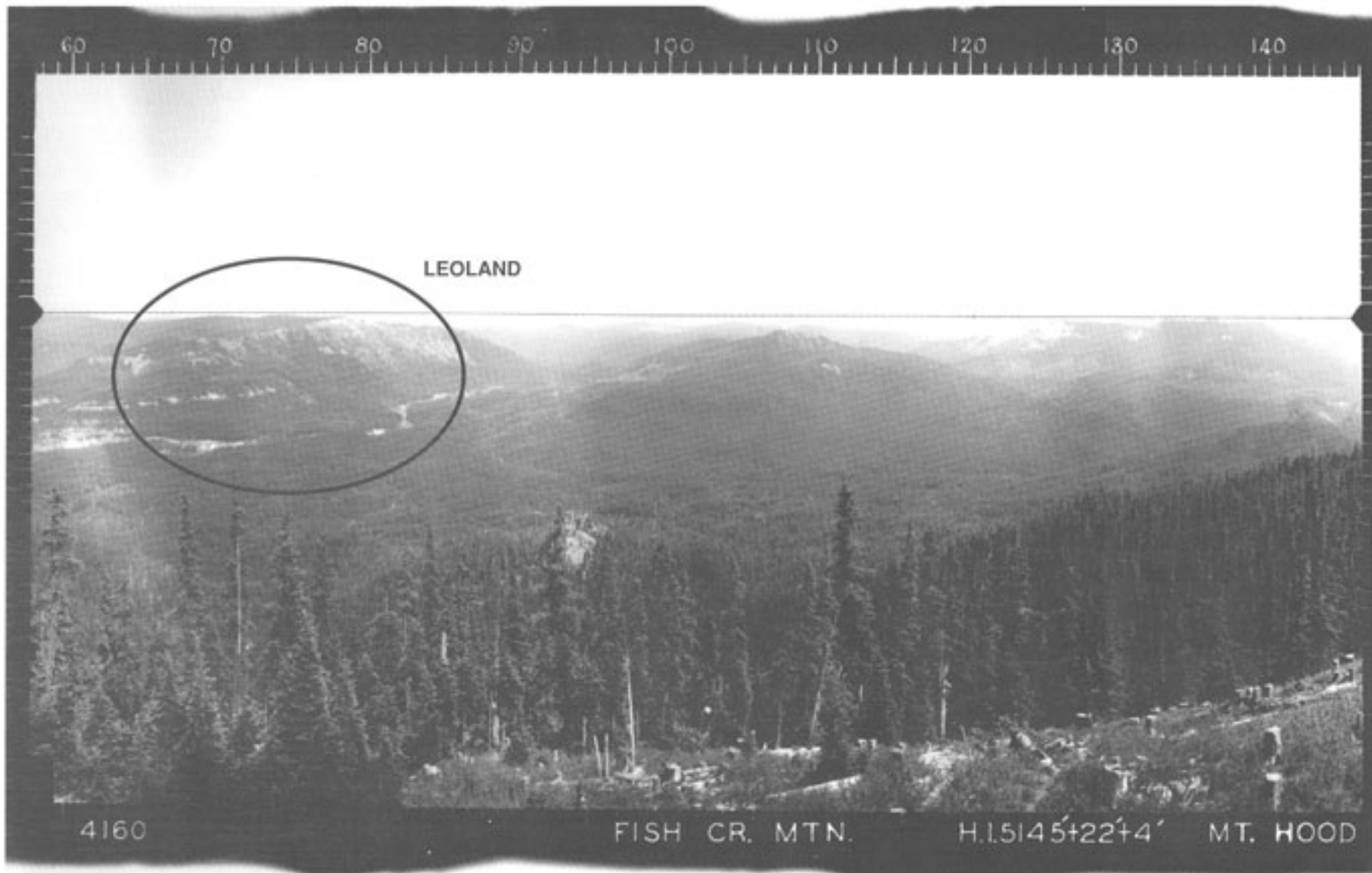
### FIRE

From Figures 14A-14C, it is apparent that the effects of fire on landscape patterns have varied within different parts of the landscape, probably due to the control exerted over fire behavior by landforms.

In the Clackamas River floodplain and its lower sideslopes (including the lower earthflow portion of Leoland), fires have created a very diverse, patchy pattern of forests of varying ages, almost as if the fire “meandered” across the landscape. Patches come in many sizes and shapes, have curvilinear edges and offer a high degree of internal structural diversity (snags, islands of residual trees, etc.). Large-scale, stand-replacing fires in this part of the landscape have probably been relatively infrequent. However, lower-intensity fires that created small openings or simply burned ground vegetation and killed a few trees probably occurred quite often.

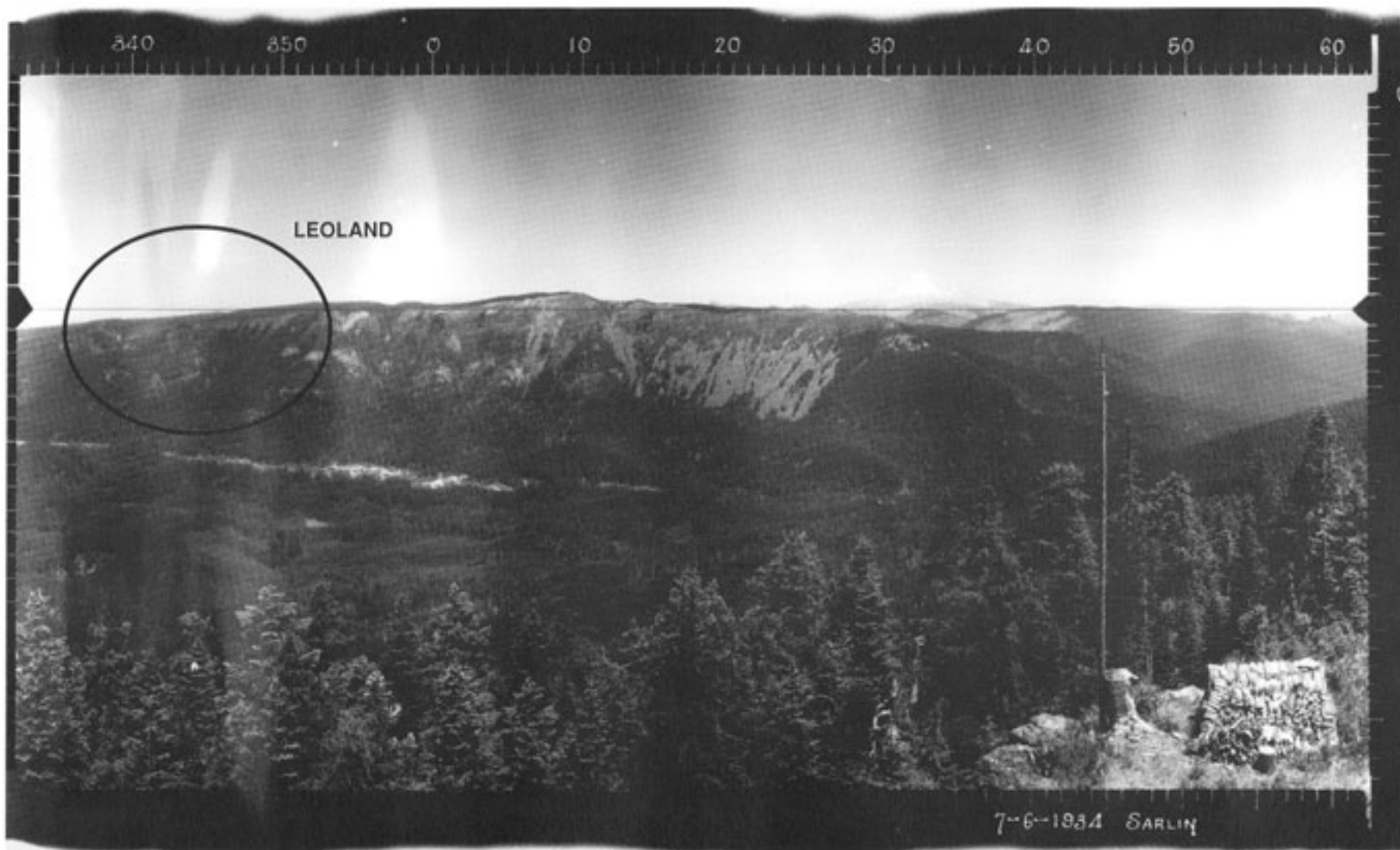
In contrast, the Mitchell Flat area (including the upper portion of Leoland) apparently experienced an extensive stand replacement fire that initiated a very uniform, evenaged forest matrix. Evidence from surrounding areas indicates that the pattern is typical for this type of landform. Infrequent stand replacement fires that burned hundreds or thousands of acres appear to have been a dominant disturbance agent in gently-sloping parts of the Pacific Silver Fir and Mountain Hemlock Zones throughout the northern Oregon Cascades. Figure 15 shows the conditions that existed shortly after one such event near Leoland.

The steeply sloping portion of the landscape between Mitchell Flat and the Clackamas River floodplain also experienced a series of fires, but with yet another pattern resulting. Here patches are quite

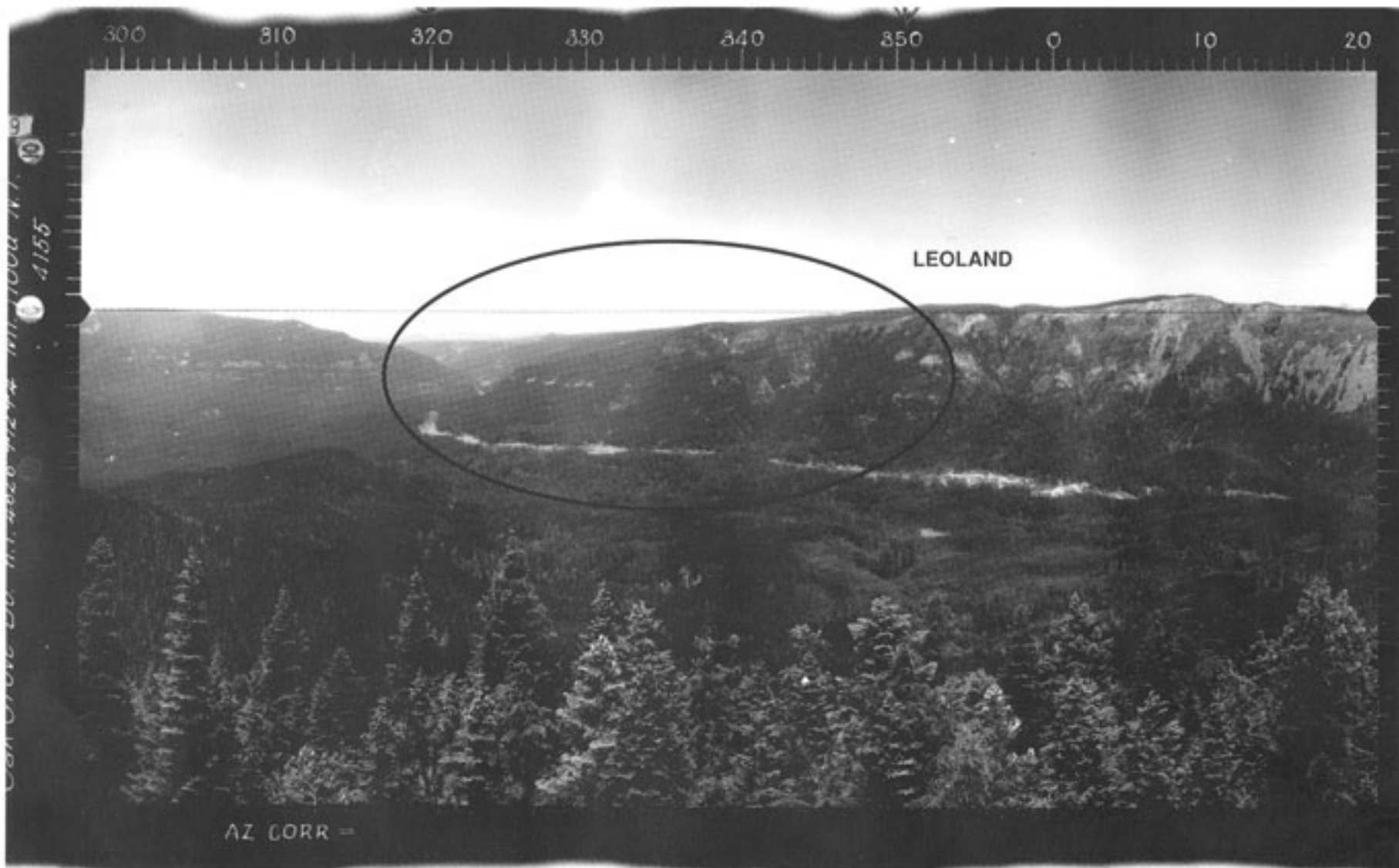


14A

Figure 14 - Landscape views of Leoland-1934, prior to logging



14B



14C

**Figure 15 - Mitchell Flat and Indian Ridge,  
from High Rock lookout, following  
Indian Ridge fire. (Photo date unknown)**



large, and appear strongly influenced by topographic features such as rock outcroppings and stream drainages. The effect is one of “fingers” of vegetation on the hillside. Fires probably burned more frequently in this portion of the landscape than any other, due to low effective moisture (dry rocky slopes, south aspect).

### **EARTHFLOW**

The instability of the landforms in Leoland have greatly contributed to landscape diversity. Numerous patches of outcropping rock, talus, shrub/forb wetlands and alder swamps are scattered throughout the earthflow area, in varying sizes. The escarpment of the earthflow has created a prominent horizontal band of outcropping rock that can be seen in Figures 14A and 14C.

SUCCESSIONAL PATTERNS

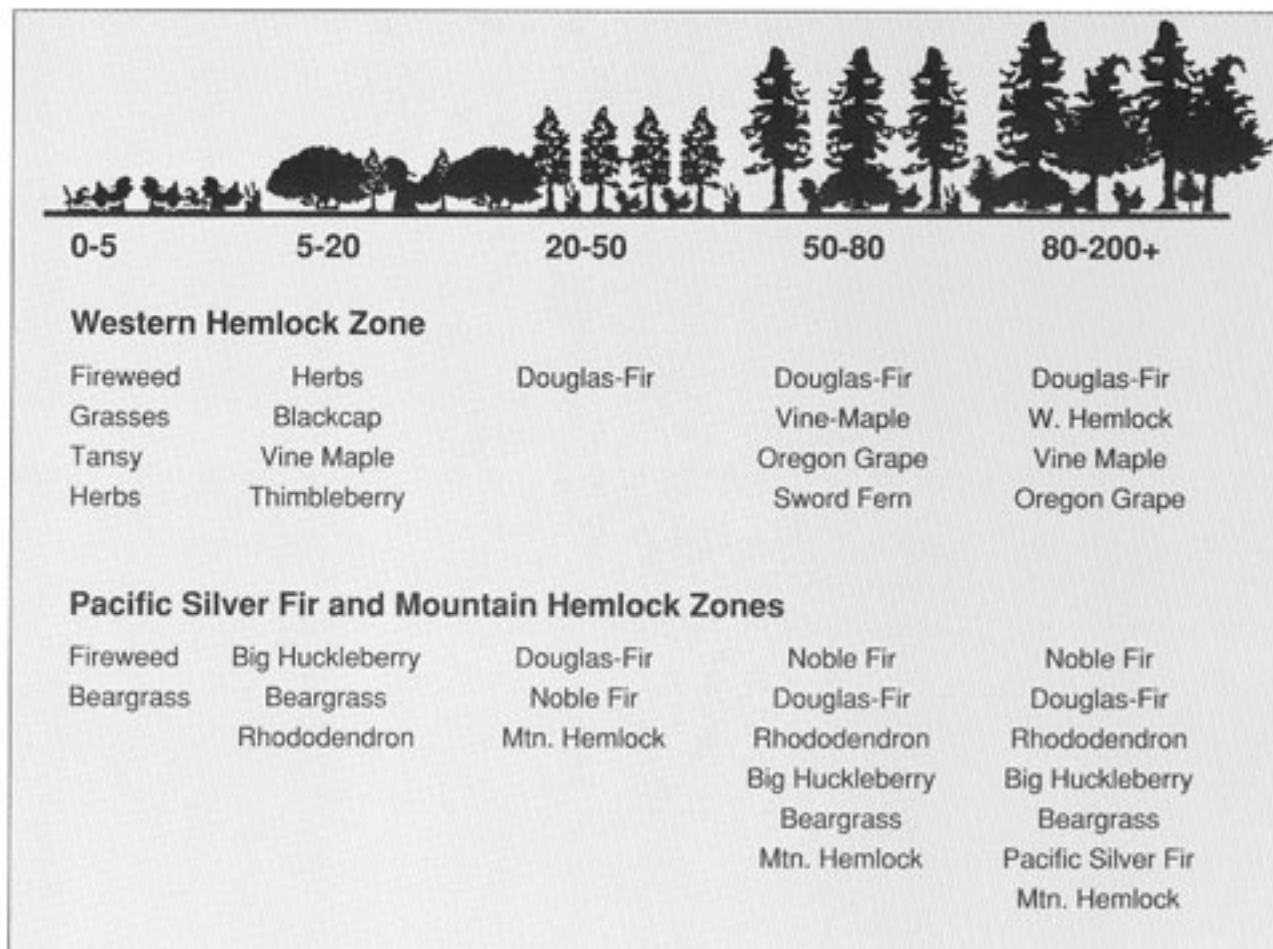
Figure 16 illustrates generalized successional trends within Leoland. In the Western Hemlock Zone, early successional stages (shrub-forb and open sapling-pole patch types) last about 10 to 15 years. From 0 to 5 years, fireweed and bracken fern are often dominant, especially on burned sites. After that, a variety of herbs and shrubs increase in abundance, including:

Shrubs	Herbs
Vine maple	Fireweed
Bitter cherry	Brackenfern
Sticky currant	Pearly everlasting
Red-flowered currant	Swordfern
Snowberry	California hazel
Trailing blackberry	Orchardgrass
Western blackcap	Bunchberry dogwood
Thimbleberry	
Salal	
Dwarf Oregongrape	
Redstem ceanothus	
Snowbrush ceanothus	
Red huckleberry	

In addition, red alder and bigleaf maple are often present (scientific and common names are crossreferenced in the Appendix).

Between 20 and 50 years, a closed sapling-pole stage dominated by Douglas-fir exists. The tree overstory is very uniform, and the understory is depauperate if it exists at all. After age 50, the canopy becomes more open and late successional forbs and shrubs (dwarf Oregongrape, vine maple, swordfern, oxalis, vanilla leaf and salal) increase in the understory. Western hemlock often starts to appear as seedlings at this stage. By age 80 the composition of the forested patches has stabilized and is likely to persist for centuries. Structural diversity (variation in tree sizes, presence of snags and logs, canopy layering) continues to increase with time until the old growth condition is reached (around age 250).

Figure 16 - General successional patterns  
in Leoland



In the Pacific Silver Fir and Mountain Hemlock Zones, the same successional patterns occur, but the species are different. The earliest successional stages have abundant fireweed and beargrass, often with the addition of rhododendron and big huckleberry. Noble fir may be present, as well as Douglas-fir, Pacific silver fir and western hemlock. These conifers also dominate mature stands, generally with an understory of beargrass, rhododendron and big huckleberry. In the Mountain Hemlock Zone portion of Leoland, it appears unlikely that mature forest patches will ever reach large sawtimber size, due to low site productivity.

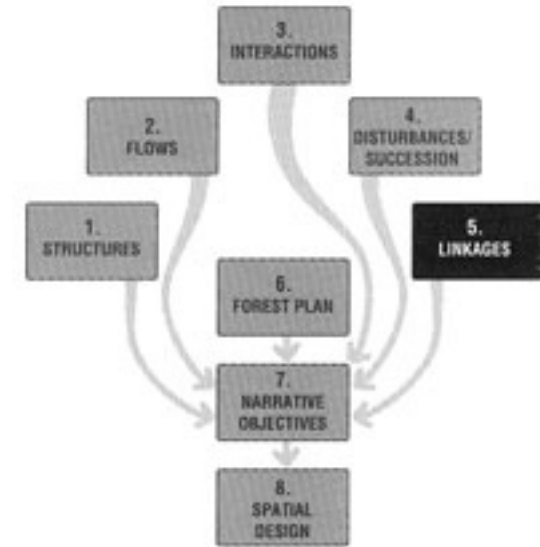


In delineation of the area on which to perform a landscape analysis, there is generally a desire to circumscribe all of the landscape flows or processes that are of concern. Anyone who has actually tried to do this realizes that it is impossible. Because different landscape processes operate at varying scales, different landscape flows require varying land areas. It is virtually impossible to avoid addressing functional linkages to areas outside the portion of the landscape being analyzed.

Therefore, the next step in the Landscape Analysis and Design Process is to determine how the analysis area being considered fits into the context of the larger landscape. A first logical step is to examine how the most important flow phenomena interact with areas outside the analysis area, and what landscape elements contribute to or affect that interaction. In other words, what things cross the borders, and how do they do it? The other aspect of the question of linkages relates to the arrangement of landscape elements in relation to the larger landscape. For example, does the analysis area represent an island of unfragmented old growth in a highly fragmented landscape? Does it contain a portion of a critical migration route for a particular species? Does it contain an important node in a larger network?

Practitioners are cautioned to avoid excessive detail in this Step, in the sense of trying to relate everything to everything else, out to an unreasonably large scale. On the other hand, there does not seem to be any systematic way of determining the point at which sufficient analysis of functional linkages has been done. The practical approach is to let logic, information and time available constrain this Step, obtaining enough understanding of the landscape relationships to at least determine whether local analysis area and National Forest objectives are being met.

## STEP 5 - LINKAGES



## STEP 5 EXAMPLE LINKAGES BETWEEN LEOLAND AND THE SURROUNDING LANDSCAPE

Linkages between Leoland and the surrounding landscape occur in various ways. In this example, four landscape flow linkages will be described - elk, deer, water and people (Figure 17). These are the same flows that were analyzed in Step 2; the difference is that this Step describes dynamics BETWEEN Leoland and adjacent areas, while Step 2 portrayed dynamics WITHIN Leoland.

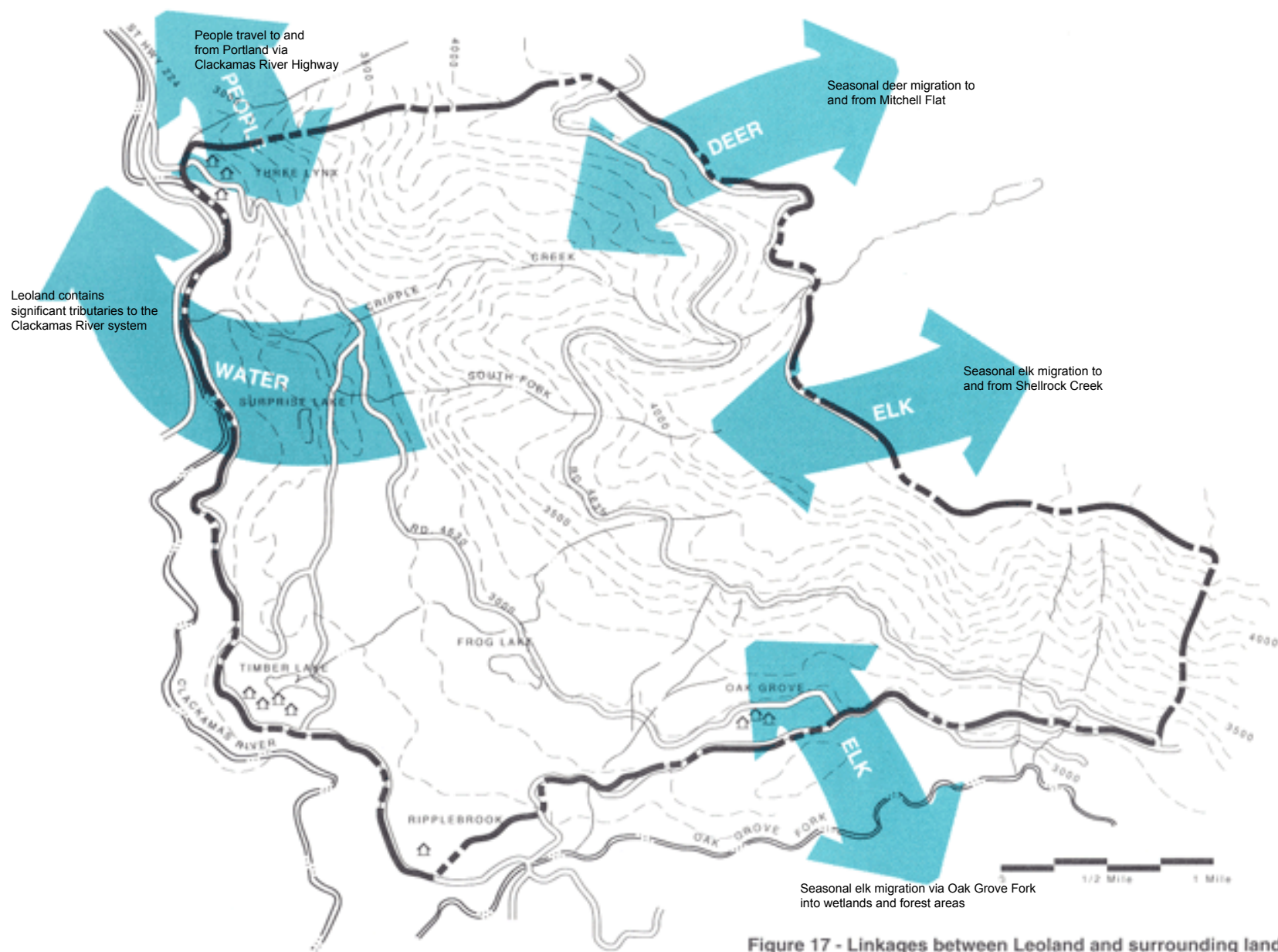
Seasonal elk migration in and out of Leoland occurs via two major routes: 1) between Mitchell Flat (summer range) and winter range in the Shellrock Creek drainage to the east, and 2) between the Leoland winter range and summer range areas to the south, across the Oak Grove Fork. These flows occur across a variety of landscape patch types that provide a combination of forage and cover.

Deer also migrate in and out of Leoland, but their pattern of movement appears more generalized than that of elk. It is known that deer range northward into the unroaded area during the summer, then move back into the lower elevations of Leoland in the winter. There is probably also travel along the Clackamas River and Oak Grove Fork. As with elk, a combination of forage openings and forest cover appears to facilitate seasonal flow.

Water also links Leoland with the outside landscape. Cripple Creek (including the South Fork) and Bull Creek are small but significant tributaries of the Clackamas River. Anadromous fish from the Clackamas River system are thought to travel a short distance up Cripple Creek. Water as a dynamic force within the earthflow area also can have downstream effects. Wetlands within the earthflow store and filter water prior to release to the Clackamas system. Water can also exacerbate slumping and other erosive events, and carry sediment to the Clackamas River.

Finally, people provide a link between the Portland metropolitan area and the Leoland landscape, both through their presence and the effects of their activities (mainly timber harvest and developments). Recreational and commercial travel occurs primarily via the Clackamas River Highway (Hwy. 224). In addition, Leoland is part of the scenic view from several locations across the Clackamas River, notably Fish Creek Mountain and Oak Grove Butte.

Figure 18 shows how the overall landscape pattern in Leoland compares with what surrounds it. Leoland is, in a sense, transitional between a highly manipulated landscape of small, uniform patches and high contrast, and a more natural landscape with a fairly intact matrix and significantly less edge. This context probably makes Leoland an important interface for a variety of species moving between the more disturbed landscape (to the south and west) and the unroaded “refugium” to the north and





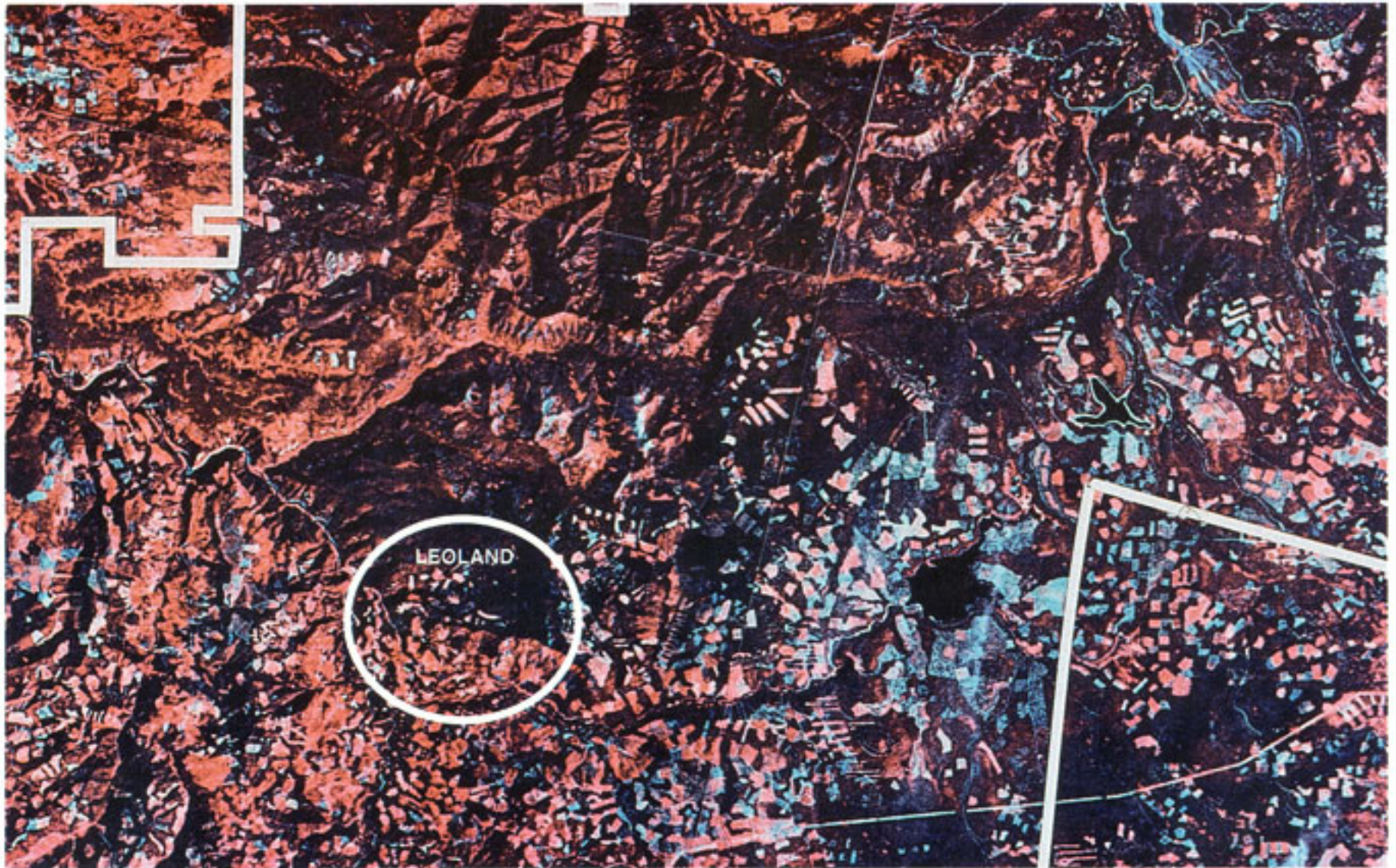


Figure 18 - Satellite photo of Leoland

east (mountain lions may be one example). If this proves to be the case, it will be important in the future to provide connectivity across the Leoland landscape in some way. Unfortunately, so little is known about this function of Leoland and what species might be involved, that it is not clear what habitat characteristics are needed for such connectivity to exist.

With this step, we move out of the Analysis Phase of the Landscape Analysis and Design Process, and into the Design Phase. The first step in design is to set objectives from which design elements are derived. Step 6 looks at what objectives about landscape pattern have already been established through the Forest Planning process. Step 7 then tailors and adds to these objectives, using information from the Analysis Phase and other sources.

Forest Plans provide a framework and objectives around which the pattern of the landscape is expected to develop, and reflect agreements made between the public and Forest Service. Retrieving statements from the Forest Plan about landscape pattern objectives is therefore an essential first step in designing the landscape pattern for a particular area.

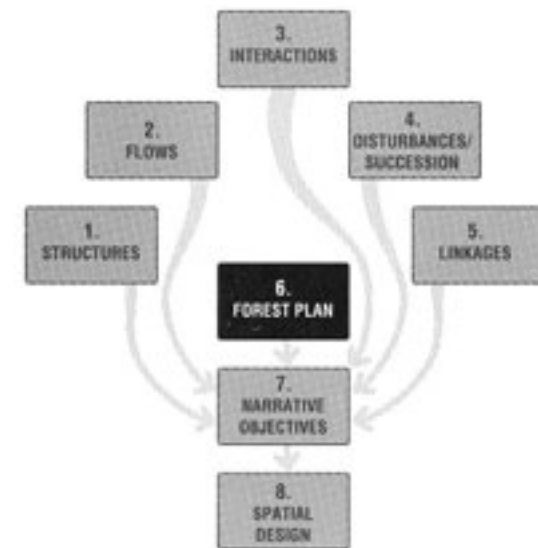
For this task, the portion of the Forest Plan of interest is the Management Direction, specifically the Forestwide and Management Area Standards and Guidelines and Management Area Direction<sup>2</sup>. It is what these documents have to say about landscape pattern that concerns us. It is often tempting at this stage to try to design ALL the management direction (e.g., levels of use of particular resources, or individual stand objectives) into the future landscape. Such a temptation should be strenuously resisted. Management direction that does NOT apply to landscape pattern will be satisfied in other parts of the planning process (e.g., design of particular activities); the task at hand is to glean from the Forest Plan what decisions have ALREADY been made about the future landscape pattern.

Usually, Forest Plan direction does not specifically address landscape pattern, but refers to it indirectly (for example, standards and guidelines describing opening sizes and arrangement in a deer and elk winter range allocation). A careful reading of Forest Plan direction will yield a good deal of information about landscape pattern that may be couched in other terms. Some things to look for:

Specifications regarding harvest unit size, composition and dispersal

Designation of priority landscape flows for a particular Management Area (e.g., deer and elk, dispersed recreation along river corridors, etc.).

## STEP 6 LANDSCAPE PATTERNS FROM THE FOREST PLAN



2. Forest Management Direction is found in Chapter 4 of Forest Plans, and contains goals, desired future condition statements and standards/guidelines (“rule” under which management activities may take place) for both the total Forest (Forestwide) and individual Management Areas. Management Areas are contiguous areas assigned to a specific management strategy. The strategy becomes the prescription for carrying out the goals and objectives for the area.



Expectations of how the landscape will “look and feel” (Visual Quality Objectives, Recreation Opportunity Spectrum classes)

Statements about proportions of an area within certain age or structural classes, or certain wildlife habitat categories (optimal cover, thermal cover, forage openings, etc.) that tie to specific landscape flows or functions

Varying levels of specificity as to landscape pattern often exist among Management Area categories within individual Forest Plans. Where the direction for a Management Area category is rather general and vague with respect to landscape pattern, there is great latitude for interpretation, which may result in arguments about what is the “correct” reading of the Plan, as well as inconsistencies of application. Where the direction is very specific, flexibility to meet local analysis area objectives may be limited. Either extreme causes a planning team to struggle with meeting the intent of a basically generic plan in the context of a real landscape. Guidance from the local decision-maker is needed when this situation arises.

It is possible that through the Landscape Analysis and Design Process, it may become apparent that the landscape ecosystem may be better protected through a different land allocation than what the Forest Plan specifies. If this is the case, adjustments to the Forest Plan can be proposed. However, the logical starting point is with the land allocation as an accomplished fact, and with the Landscape Analysis and Design Process determining how the landscape will function within that framework.

## STEP 6 EXAMPLE FOREST PLAN ALLOCATION IN LEOLAND

Figure 19 shows the Management Area categories for Leoland, from the Mt. Hood National Forest Land and Resource Management Plan (USDA Forest Service, 1990). Direction regarding landscape patterns for each management area is summarized below<sup>3</sup>. To simplify the example, the existence of Habitat Conservation Areas, Critical Habitat Areas, and any other layers of temporary or proposed direction that have been superimposed on the Forest Plan allocation have been ignored.

### FOREST-WIDE DIRECTION

Landscape pattern - Fragmentation of old growth blocks >100 acres should be minimized. At the same time, created openings should be separated by leave blocks large enough to contain a logical harvest unit (these two statements may be difficult to satisfy together in the same part of the land-

3. This information represents a paraphrase of the Goal statements, Desired Future Condition and both Forest-wide and Management Area Standards and Guidelines that relate to landscape pattern. The attempt was to restate the direction in landscape terminology, with a minimum of interpretation.

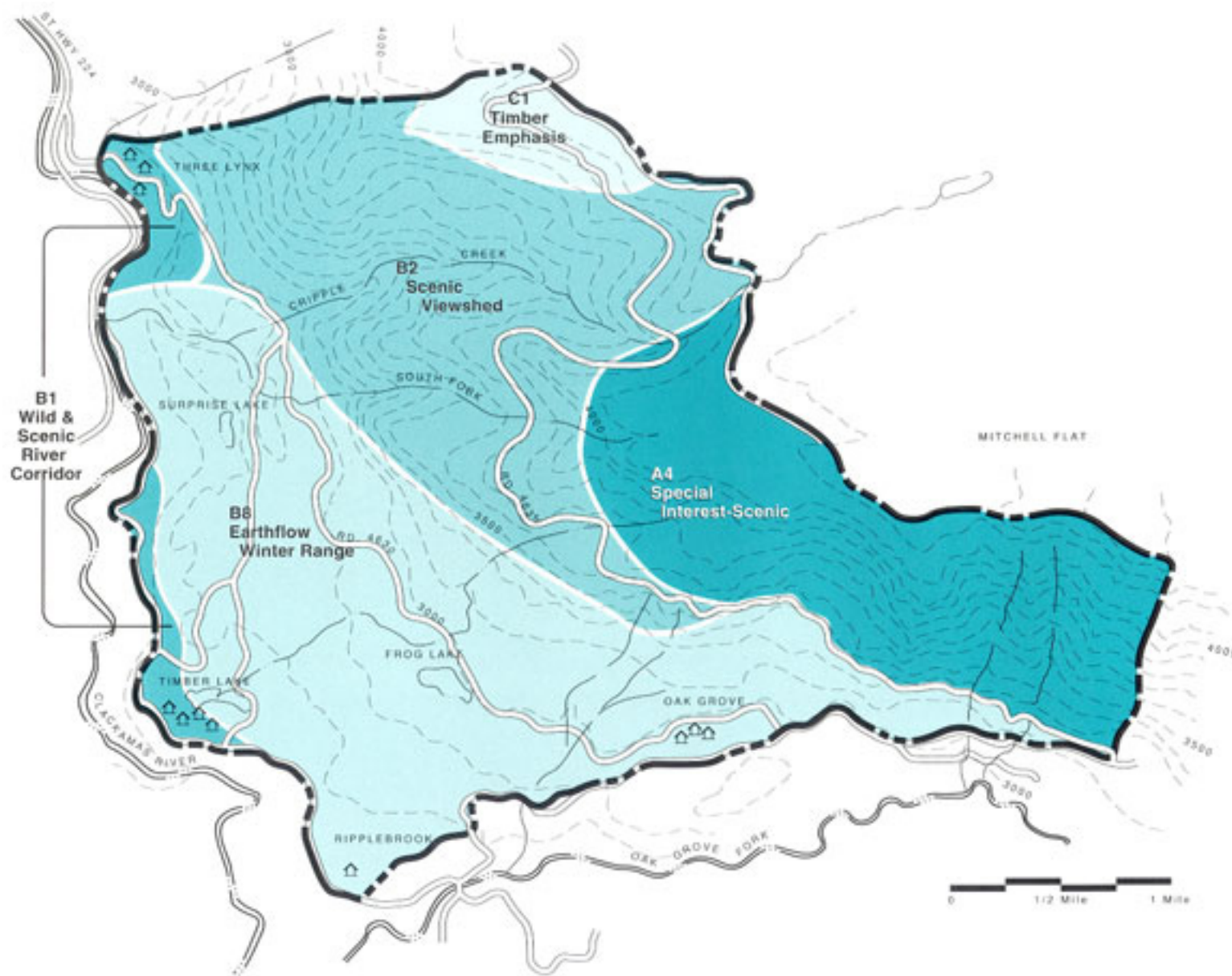


Figure 19 - Leoland Forest Plan Management Areas

scape). Existing natural openings (rock outcroppings, meadows, wetlands) should be protected, and should not have large created openings adjacent. In general; no more than 35% of the potentially forested area should be in the shrub/forb or open sapling-pole patch type (“hydrologically disturbed”) at a time, and the proportion of those patch types within the landscape should remain relatively constant through time. Further, at least 20% of the area should be in the large sawtimber patch type (optimal cover), and an additional 10% in the closed sapling-pole or later successional stages (thermal cover). In winter range the thermal cover proportion should be at least 20% .

Patch specifications - Shrub-forb openings created to provide deer and elk forage should be irregularly shaped, and configured such that there is never more than a 600-foot distance to a forested edge (thermal cover). In the Western Hemlock and Pacific Silver Fir Zones, shrub/forb and open sapling-pole patches should not exceed 60 acres in size; openings are restricted to 40 acres or less in the Mountain Hemlock Zone. On an area basis, the average size of shrub/forb and open sapling-pole patches should be less than 20 acres in winter range and less than 30 acres everywhere else. Unevenaged patches should not be created on steep (>30%) slopes unless logging systems can be set such that damage to residual trees will be avoided. Corridors - Riparian buffers (typically a 100’ minimally-disturbed zone on either side of a stream) should be maintained in a natural, mature forest condition. In winter range, the density of roads open to vehicle travel should not exceed 2.0 mi/mi<sup>2</sup>. Elsewhere, the density should not exceed 2.5 mi/mi<sup>2</sup>. Trails should be developed to disperse recreational use.

### **DIRECTION FOR SPECIFIC MANAGEMENT AREAS**

A4 - Special Interest - Scenic (Roaring River Special Interest Area). The goal of this designation is to protect and promote public enjoyment and recreational use of the scenic values of the unroaded area. The Forest Plan has little to say about the landscape pattern for this Management Area, except that it is to have a predominantly natural appearance, especially from roads, trails and areas of high recreational use.

B1 - Clackamas Wild and Scenic River Corridor (Recreational Segment). There is very little stated about landscape pattern for this management area. The goal for this segment is mainly to protect the visual quality from Hwy. 224 and the riverside trails. Evidence of human activities should not dominate the landscape.

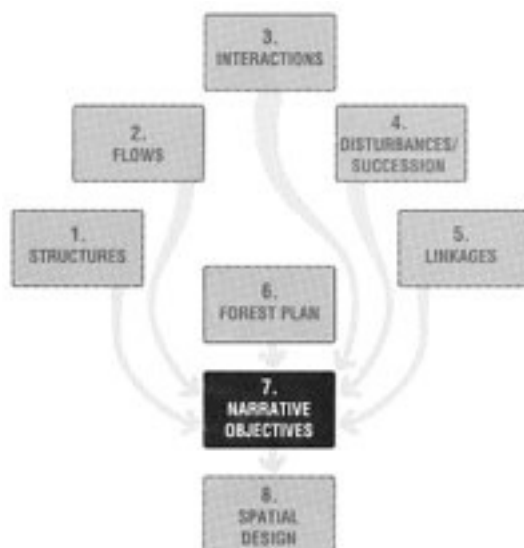


B2 - Scenic Viewshed. The goal here is to provide visually attractive scenery as seen from Hwy 224. The landscape should look primarily forested, with openings that appear natural, and in harmony with the landforms (this area already has a number of natural rock openings that provide some pattern diversity within the general forest matrix). The transportation corridors should foster dispersed recreational use and provide views of unusual or interesting landform features.

B8 - Earthflow. This Management Area is intended to protect large, slow-moving earthflows from acceleration of earth movement, by maintaining their hydrologic and physical integrity. The Leoland earthflow is considered “high risk”, which means a very conservative approach to removal of forest cover is taken. The direction described in the Forest Plan for the landscape pattern in this Management Area is quite specific. Basically, it is a matrix of mature and young forests with a few scattered small created openings, arranged such that there are fairly large blocks of unfragmented mature forest. The landscape pattern should, at any one time, have no more than 10% of the area in an open sapling-pole or shrub-forb patch type (be hydrologically disturbed). (Note: The earthflow portion of Leoland does not presently meet this standard). Apart from that, a variety of structural classes (open sapling-pole, small and large sawtimber) will be part of the landscape pattern. Since this is also deer and elk winter range, 25% of the landscape area should be in large sawtimber (optimal cover) consisting of blocks 30 acres or larger, at least 600 feet across. Interspersed will be small (10 acres or less) shrub-forb openings for deer and elk forage.

C1 - Timber Emphasis. The goal of this Management Area is to produce wood products through regulated timber harvest. There are some direction statements regarding landscape pattern for Timber Emphasis areas, but great flexibility with respect to arrangement and size of created openings exists. The landscape pattern is expected to be patchy, with a mosaic of patches representing the full range of successional stages (except, once full regulation is achieved, old growth). In general, created openings range in size between 20 and 40 acres, and should blend with the natural landscape character. Fragmentation should be minimized where possible.

## STEP 7 LANDSCAPE PATTERN OBJECTIVES (NARRATIVE)



In this Step, information gathered in previous Steps (and also from other sources) is used to further develop local analysis area objectives regarding the landscape pattern, in addition to what was gleaned from the Forest Plan. Specifically, the future landscape will be described in terms of the types and arrangement of landscape elements (patches, corridors, matrix). These statements constitute the “design elements” of the future landscape. At this point, we will not be too concerned about the placement of these elements on the land; the step that follows will provide the actual design of the pattern on the landforms. On the other hand, if information about the desired location of certain attributes IS available, it can be included at this Step. But the emphasis here will be on a narrative description of the future landscape pattern.

It is probably not possible to have a discussion about landscape objectives (or any other kind) in the absence of personal values; everyone has expectations about what landscapes “should” provide, ecologically, aesthetically and economically. In this Step, practitioners may find it very frustrating that the landscape pattern objectives do not spring fully-formed from the landscape analysis process (Steps 1-5). To help alleviate some of this frustration, the next paragraph identifies some sources from which landscape function and pattern objectives may be derived.

First of all, the Management Area Goal Statements from the Forest Plan are good indicators of the emphasis placed on various resources in the analysis area as a whole. While not specific as to landscape pattern, they generally provide a hierarchy of values or expectations for the analysis area. Next, scoping of public opinions regarding how the Forest Plan will be implemented within the analysis area will have taken place at some point, and important resource issues will have been identified. This information can be used to prioritize landscape functions that are of particular public concern in the analysis area. In some cases it will be desirable to involve interested members of the public directly in developing objectives about landscape patterns and functions. Finally, reports, maps and observations of resource specialists are necessary in this Step, as they further define the nature and spatial dynamics of landscape functions. It bears emphasis at this point that the task in this process is NOT to deal with ALL the resource issues that may be present for a particular planning area, but only those that relate to landscape pattern. Other issues are treated in other parts of the overall planning or design process.

Once important landscape functions/resource issues have been identified, the information from the Analysis Phase (Steps 1-5) is used to make interpretations about what structural elements (matrix,

corridors, patches) and landscape patterns are needed to provide for them. Using the following questions will help lead toward statements about landscape pattern objectives:

Are there some rare, unusual, critical or unique landscape elements we want to protect or enhance, e.g., wetlands, travel corridors, blocks of old growth with interior habitat, etc.? Are there patches or areas of the matrix between which connectivity should be maintained?

Is there anything missing that should be introduced or restored (e.g., “naturalize” square patch shapes, restore native community composition to disturbed areas, etc.)?

To what extent, and where, do we want to emulate certain elements of natural landscape patterns? If one believes that 1) “natural” levels of diversity (of composition, structure and process) sustains ecosystem resilience, and 2) species diversity is fostered by habitat diversity, then there is much to be gained by mimicking some aspects of landscape patterns created through natural processes. Just what these aspects are and how they can be re-created in a managed landscape deserves serious consideration at this step.

Are there areas of the landscape where it is desirable to minimize fragmentation? Are there areas where a high degree of edge and contrast is desirable? Are there areas where gradual changes rather than sharp edges (landscape without lines) are desirable?

Now, objectives about landscape pattern from the Forest Plan is combined with the answers to the questions above to develop statements about desired future landscape patterns, i.e.:

What kinds, sizes, shapes and arrangements of patches/corridors/matrix are desirable in different parts of the landscape? Sometimes it is helpful to answer this separately for each Forest Plan Management Area Category.

There will be those who become frustrated at this point because there may not be one “right” answer to these questions. It must be pointed out that the process of design IS highly subjective. Sometimes there is a feeling that it is “wrong” to make statements about the future landscape pattern unless the process is impersonal and objective, and that it would therefore be better to simply develop individual projects where opportunities exist consistent with the Forest Plan, without describing the landscape a priori. However, where the Landscape Analysis and Design Process is informed by 1) goals, stan-

dards and guidelines and Desired Future Condition statements from the Forest Plan, 2) public input regarding resource issues for the particular planning area and 3) best resource expertise available, it is not only appropriate but necessary to describe how the future landscape will look and function. With or without such statements, land managers manipulate landscapes; it makes more sense to create landscape patterns by design than by accident.

It is important to emphasize here that this Step does NOT involve making decisions about land allocations. Those decisions were made at the Forest Plan stage. What this Step does is describe HOW those earlier decisions will be carried out for a particular area, with respect to landscape pattern and function.

As a final note, practitioners are encouraged to avoid being excessively circumscribed by the present in thinking about the future. The existing pattern of the landscape may be quite different from what is desired, but this is more a challenge than a barrier. Even though “fixes” (or restoration) of landscape patterns may take a long time to implement, some actions are more likely to lead in that direction than others. This being the case, it may be desirable to describe “interim” landscape patterns that will eventually lead to the desired end. These interim patterns act as near-term checkpoints, and help give focus to management activities that will take place in the near future.

#### **STEP 7 EXAMPLE LEOLAND LANDSCAPE PATTERN OBJECTIVES**

The starting point for this Step was a variety of maps, reports and personal observations from resource specialists, and a report on significant resource issues that had been developed from public comments prior to commencement of the Landscape Analysis and Design Process. These sources were used, along with information from the Analysis Phase (Steps 1-5) to answer the questions listed below:

Q: Are there some rare, unusual, critical or unique landscape elements we want to protect or enhance?

A: The following Leoland elements should be protected:

- Wetlands surrounded by mature forest in crucial winter range area (wildlife)
- Old growth in Clackamas Wild & Scenic River corridor (recreation, visual and wildlife)
- Mature forest riparian corridor in Cripple Creek (fisheries, water quality and recreation)
- Remaining mature forest patches with interior habitat (wildlife)

- Rock outcroppings (natural diversity)
- Integrity of forest matrix in rain-on-snow and earthflow areas
- Roads 4635, 4630, 4631 and 4630-200 as the major travel network

Q: Where should connectivity be maintained?

A: For wildlife purposes, connectivity is particularly important between wetlands and mature forest stands in crucial winter range. Connectivity is also important along deer migration routes between Mitchell Flat and winter range, but it can occur across a variety of patch types.

Q: Is there anything missing that should be introduced or restored?

A: The following opportunities for restoration exist:

- More natural plant diversity in altered wetlands and plantations, especially in winter range
- Close and revegetate dense network of spur roads below Frog Lake and Timber Lake Job Corps Center, to eliminate poaching and restore a more natural landscape pattern and flows
- Naturalize the shapes of clearcuts in the Scenic Viewshed and Special Interest-Scenic areas
- Restore breaks in Cripple Creek riparian corridor

Q: To what extent, and where, do we want to emulate certain elements of natural landscape patterns?

A: Emulate natural patch shapes in Earthflow, Scenic Viewshed and Special Interest-Scenic Management Areas. (See pp 4.28-4.32 for a description of the “natural” landscape pattern).

Q: Are there areas where it is desirable to minimize fragmentation, etc.?

A: Minimize fragmentation in the Scenic Viewshed. In winter range some edge and contrast is desirable (constrained by Forest Plan Standards and Guidelines).

Next, the statements about landscape pattern from the Forest Plan (Step 6) are combined with the answers to questions above, using both to identify landscape pattern objectives specifically for the Leoland area. These constitute the design elements that will be used in the Step that follows (Step 8).

Q: What kinds, sizes, shapes and arrangements of patches/corridors/matrix are desirable for each Management Area?

- |                                |   |
|--------------------------------|---|
| Special Interest - Scenic (A4) | <p>Landscape appears natural, especially from Rd. 4635 and trail #704</p> <p>A diverse and highly textured pattern of “fingers” and patches of forest interspersed with irregular rocky openings on the steeply-sloping, south-facing portion below Mitchell Flat</p> <p>On Mitchell Flat itself, small irregularly-shaped openings in the forest matrix to provide views to the south.</p> <p>Additional viewpoints on the southern edge of Mitchell Flat, connected by a network of trails.</p>   |
| Clackamas Wild/Scenic R. (B1)  | <p>A forested corridor, emphasizing old growth character.</p>   |
| Scenic Viewshed (B2)           | <p>In W. portion of Cripple Creek drainage (vicinity of large interior forest patch), a forested matrix with a few small openings that emulate natural rock outcroppings.</p> <p>North slope of drainage appears forested. Interior forest patch retains non-edge characteristics. No mid-slope roads.</p> <p>Mature forest riparian corridor along Cripple Creek and its lower slopes.</p> <p>In the upper portion of Cripple Creek and areas of the Scenic Viewshed outside the Cripple Creek drainage (where the forest matrix is currently fragmented by clearcutting) larger openings within the forest matrix, contoured to harmonize with landforms.</p> |

## Earthflow (B8)

A matrix of mature and young forest with interspersed small (10 acres or less) openings. At least 1/3 of the matrix (which makes up at least 75% of the total Management Area) is large sawtimber in patches of 30 acres or larger (the rest can be small sawtimber). Young and mature forest stands have a hardwood component (red alder and bigleaf maple).

Irregularly shaped (to minimize distance to a forested edge) and variable-size (with a maximum of 10 acres) openings. Similar in pattern to that seen in historic photos of the Clackamas River floodplain (see Step 4), resulting from natural fire patterns. The acreage in shrub/forb and open sapling/pole patches does not exceed 10% of the total earthflow area. Openings are dominated by native forage species.

Wetlands surrounded and connected by stands that retain cover characteristics of mature forest.

## Timber Emphasis (C1)

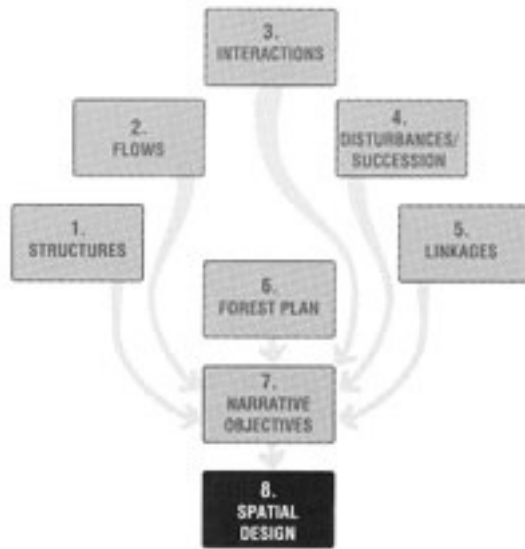
Similar to the portion of upper Cripple Creek within the Scenic Viewshed, i.e., larger openings shaped to conform with natural landform and vegetation patterns. A higher proportion of residual trees retained, individually and in groups, to mitigate growing season frost.

Finally, an additional question was posed:

Q: Is it necessary to adjust the Forest Plan to accomplish the above objectives?

A: No, the statements above are consistent with the existing Forest Plan allocation and Management Direction.

## STEP 8 FOREST LANDSCAPE DESIGN



Once written objectives have been developed (Step 7) that describe in words the target landscape pattern of an analysis area, they must be given spatial form in the context of the actual landforms. Thus, Step 8 of the Landscape Analysis and Design Process is the task of designing landscape patterns that meet certain objectives: where the ideal becomes real.

### DESIGN AND PLANNING

“Planning” is usually a two dimensional exercise that does not result in a defined spatial pattern on a real landscape. Products such as land use maps are derived from a planning process. They describe what is allowed to occur in various areas, and provide guidance or parameters about various land uses, but fall short of organizing defined patterns that can be described and tested in three dimensions. “Design” takes the next step, into the realm of deliberate pattern creation. Whereas planning can be described as a left brain, analytical activity, design is a right brain, intuitive one. In the Landscape Analysis and Design Process, the language of landscape ecology connects “planning” to “design”, by its focus on patterns in the landscape. Thus, in Step 8, the goal is to describe the relationship of future vegetation patterns to landforms, develop a conceptual circulation system, and fit the overall program to the landscape in a way that allows it to be visualized, mapped and described.

### THE BRITISH ARE COMING

Much of the inspiration for this approach comes from work done by Landscape Architects in the British Forestry Commission over the past 25 years. Once largely covered in forest, Britain was gradually deforested over a several thousand-year process of settlement, agriculture, timber cutting, and sheep grazing. After the First World War, the British began “afforesting” worn out grazing areas with conifer plantations. These tended to be monocultures of straight rowed, non-native species, completely out of harmony with the natural and cultural landscape. Public resistance grew, mostly on aesthetic grounds, but also for ecological reasons. The British response was to develop a “redesign” process (through the work of Dame Sylvia Crowe), that sought to better harmonize forests with landforms and open vegetation patterns. Increasingly, species and structural diversity, developing recreation opportunities, and preserving or restoring special plant communities or habitats are being considered, as well as timber production. Thus, while the British system is more heavily weighted toward aesthetics than the Landscape Analysis and Design Process, the overall approach is still useful.



In the words of Simon Bell, Chief Landscape Architect for the British Forestry Commission, “the design basically makes manifest in landscape terms what the Desired Future Condition actually is, where it goes, how much there is and the patterns it creates ....” The linkage of vegetation patterns to underlying landforms is perhaps the most useful innovation developed by the British, in that the landform is viewed as the “permanent” feature of the landscape; vegetation patterns may come and go, but the geomorphology remains.

## ELEMENTS OF THE DESIGN STEP

Designing at the scale envisioned in Landscape Analysis and Design is by necessity coarsegrained. A broad-brush, sweeping approach is appropriate; one must think in terms of groupings of landscape elements rather than single stands. Someone has referred to such large scale design as “painting with a comet’s tail.” The goal should be to create an overall picture of desired vegetation patterns within the analysis area, setting the stage for more detailed work to follow.

To begin the design stage a “Landform Analysis” is carried out. This helps bring out the three-dimensional character of the landscape that is often lacking in traditional maps, particularly in mountainous landscapes. (In gentle topography, more subtle variations, such as soil types or water table depth could be relied on as influences on the design.) An analysis of the topography is an important first step because it defines, in large part, the operational environment of the landscape. It has a strong influence on natural vegetation patterns, flows of animals, wind and water. It is also what is “seen” as the underlying form of the landscape, and human-influenced vegetation patterns or roads that are disharmonious with landforms offend the intuitive sense of what is appropriate. Additionally, landforms are much longer-lived than the vegetation patterns that occur on them at any given moment. By “reading” the landforms, one can get a feel for how vegetation patterns might be placed in a manner that promotes connectivity, or what “mixes” of patch types reflect natural landscape diversity. Landforms should be analyzed in both two and three dimensions so as to reveal both the most prominent and subtle topographic features.

The second piece of information useful as background for design is a comprehensive “Opportunities and Constraints Map.” This map shows the most important form-giving influences, such as where forage openings are needed, where connectivity should be improved, and which areas should be protected or restored. Again, the focus should be on items that will influence the large spatial patterns, although some site specific issues can be identified here as well, particularly if it is desirable to track

them into later stages. Identifying and agreeing on opportunities and constraints is also a good reality check for the project team that helps build awareness about the limits of a particular landscape to satisfy every desire.

As mentioned earlier, the leap from purely analytical thinking to creative thinking requires shifting to intuitive skills. There is no one “scientifically correct” way to manage forest landscapes. While the science of landscape ecology is essential as background for making reasonable decisions, no amount of analysis can substitute for creative thinking. On the other hand, once the design phase is reached, creativity in the absence of science will not likely result in solutions that preserve the ecologic functions that are of concern. It is also important to note that there is no known method to “design” the way out of unresolved policy conflicts. Whether to place an area in wilderness or timber production is not a design question; land use policies must be worked out to some level of satisfaction (e.g., Forest Plans) before design can have a chance to succeed.

There has been some confusion about the role of individual resource overlays (mapped via GIS or manually) in generating a target landscape design. Many are familiar with Design With Nature (McHarg, 1969), in which overlays may appear to magically generate solutions without the need for subjective action. In fact, one cannot build a design directly from overlays, but must use them to reveal important features about an area that should be retained or enhanced. The idea is to document opportunities and limits inherent in the analysis area by mapping them, then to put these maps aside, develop designs, and test designs against the resource concerns. Again, the mapping is purely analytical, while the design is relying on the subjective ability to “read the landscape.”

There is nothing harder than staring at a blank piece of tracing paper, waiting for a design to drop in from... someplace. At some point the designer must take pen to paper (or mouse to digitizer) and begin laying out the broad scale forest patterns that are the essence of the target landscape design. It is easiest to begin with the most obvious, usually those areas that are to be protected or only minimally altered, such as stream corridors, wetlands, old growth blocks or Management Areas in a “preserve” status. The idea is to give form to areas that will ultimately be treated in a similar manner. Thus one area might be “mature, unfragmented forest”, another with frequent man-made openings, a third permanently maintained openings, and so forth. There may be places where restoration of the vegetation to something very different from what exists at present would be desired, such as replacing a failed plantation of off-site species. On the Shawnee National Forest in Southern Illinois for example, a

long term project is underway to convert large areas back to an open “Oak Barrens”, a pre-European settlement landscape once common in that region, but now almost non-existent (Stritch, 1991). Designs should be conceptual, or “bubble diagram” style at first. Several options can be developed and considered. Viable alternatives are then reviewed by the project team and/or interested members of the public, with an eye towards determining which one best satisfies the objectives laid out in Step 7.

Once a concept design is agreed upon, it is further developed and refined to a level of resolution appropriate to the area. Individual harvest units could be proposed, roads or trails suggested, potential projects identified. Generally the goal of this stage is to paint a picture of the large scale landscape pattern that is clear enough for people to see and interpret, and for further development of site-specific projects.

The human circulation system (roads and trails) should be an integral part of Step 8. Human access routes can have both negative and positive effects on the landscape flows of a particular area. Negative consequences include interruption of wildlife migration, siltation of streams, increase in poaching or harassment, and visual unattractiveness. Positive consequences include providing human access to an area, and to the extent that humans are stewards and users in the landscape, they are vital corridors. It is very important to analyze the circulation pattern with these things in mind. “Access and Travel Management” is a planning method that can be easily integrated into the Landscape Analysis and Design Process to help determine access needs and problems.

### THE ROLE OF THE LANDSCAPE ARCHITECT

Landscape architects are generally the resource specialists most likely to be at home with the spatial design processes inherent in completing Step 8, since something like “master planning” is generally part of their training. Since tradition has dictated that the focus of landscape architects be primarily on aesthetics (mostly visual appearance), it is important to emphasize that the design task as described here is not driven by aesthetics, but rather synthesizing objectives with real landscapes, applying design techniques to generate and display the results. Consequently, the landscape architect needs to become somewhat separated from visual and aesthetic concerns in Step 8, and become a designer occupied with integrating and displaying the manner in which the Step 7 objectives become realized in the analysis area.

Put another way, Visual Quality Objectives (VQO's) are useful in the information-gathering stages of Landscape Analysis and Design, including location of viewpoints, determination of sensitivity levels, and assessment of existing conditions. But once into Step 8, landscape architects must be willing to put their “visuals” hat on the shelf and put on a “synthesizer’s” hat. Where VQO's tend to impose the aesthetic of the landscape from above (based on degree of naturalness), Step 8 generates the aesthetic based on the synthesis of multiple objectives within the landscape. To the extent that the design is consistent with Forest Plan objectives, the VQO's will in any case be satisfied.

Step 7, by describing the landscape pattern objectives for Leoland, set the stage for the subsequent design. A question that often arises from those who have seen the Leoland example of Step 8 is “But how did you make those lines right where they are?” This question is difficult to answer, in that the design of the landscape pattern is not arrived at by completely objective means, as has been pointed out.

### **STEP 8 EXAMPLE - LEOLAND “TARGET LANDSCAPE” DESIGN**

In Leoland, the landscape architect took the objectives stated in Step 7, prepared a Landform Analysis and Opportunities and Constraints map (Figures 20 and 21), and then subjectively began to allocate patterns to particular areas. The map of Landscape Elements (Figure 10) was very useful in providing clues as to where one pattern might merge with another, especially where an existing patch corresponded well with a landform. It was determined that five pattern “types” were needed in Leoland: 1) unfragmented, mature forest, 2) “patchy” forest with small openings, 3) open forest with huckleberries, 4) natural brush openings, and 5) developed areas with restored community composition. The design sorted out these patterns on the ground.

The mature, unfragmented forest is the pattern type that forms the matrix for Leoland, so it was located first. (Figure 22) This was done by providing a shape that followed landforms around the existing interior habitat and riparian areas. Several alternatives were considered. Once the matrix pattern was satisfactory, the “patchy” forest areas were defined, again deriving the shapes by fitting edges to landforms and existing patches where possible. The other pattern types then more or less fell into place. The “open forest with huckleberries” area was located at high elevations in the Pacific Silver

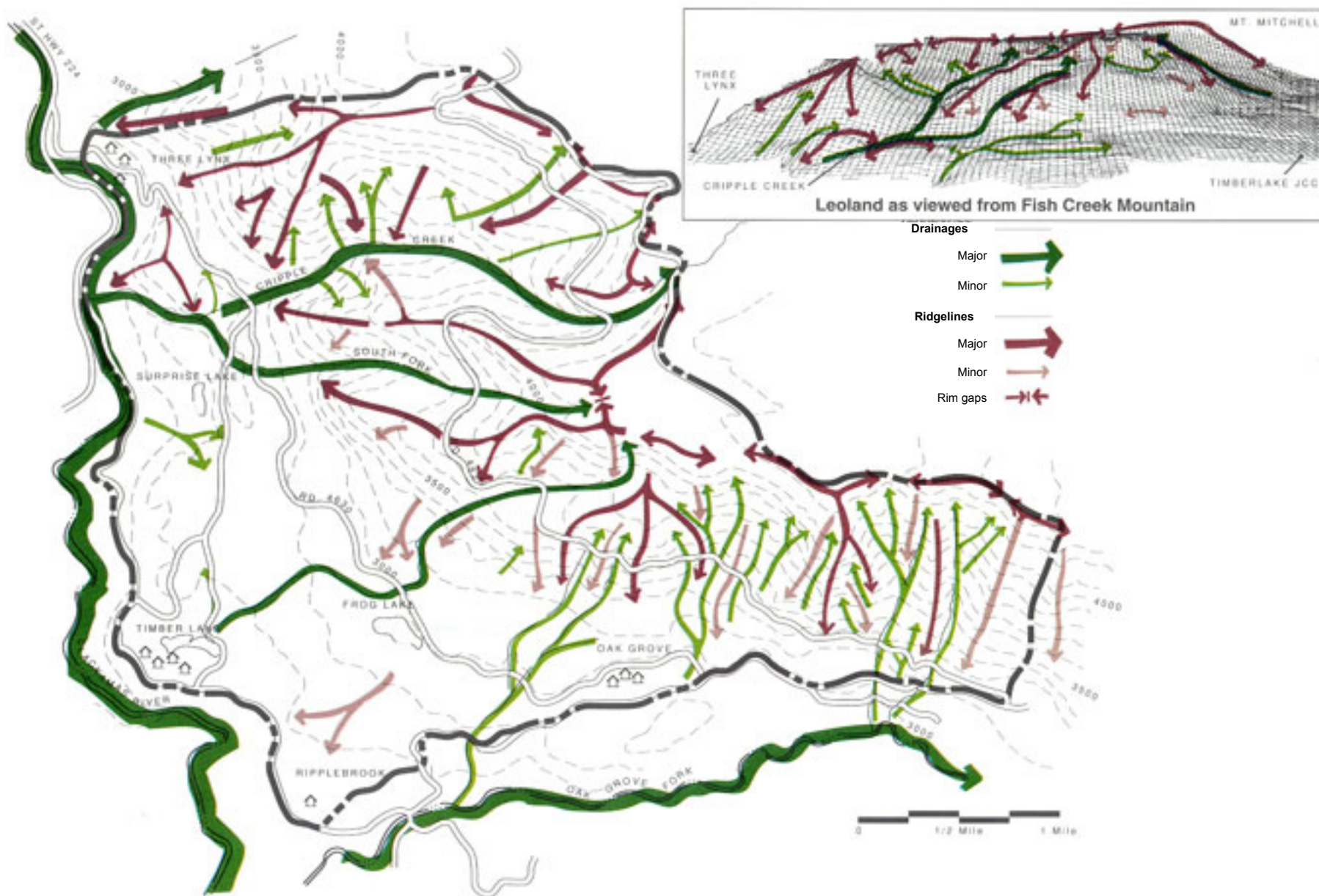


Figure 20 - Landform analysis

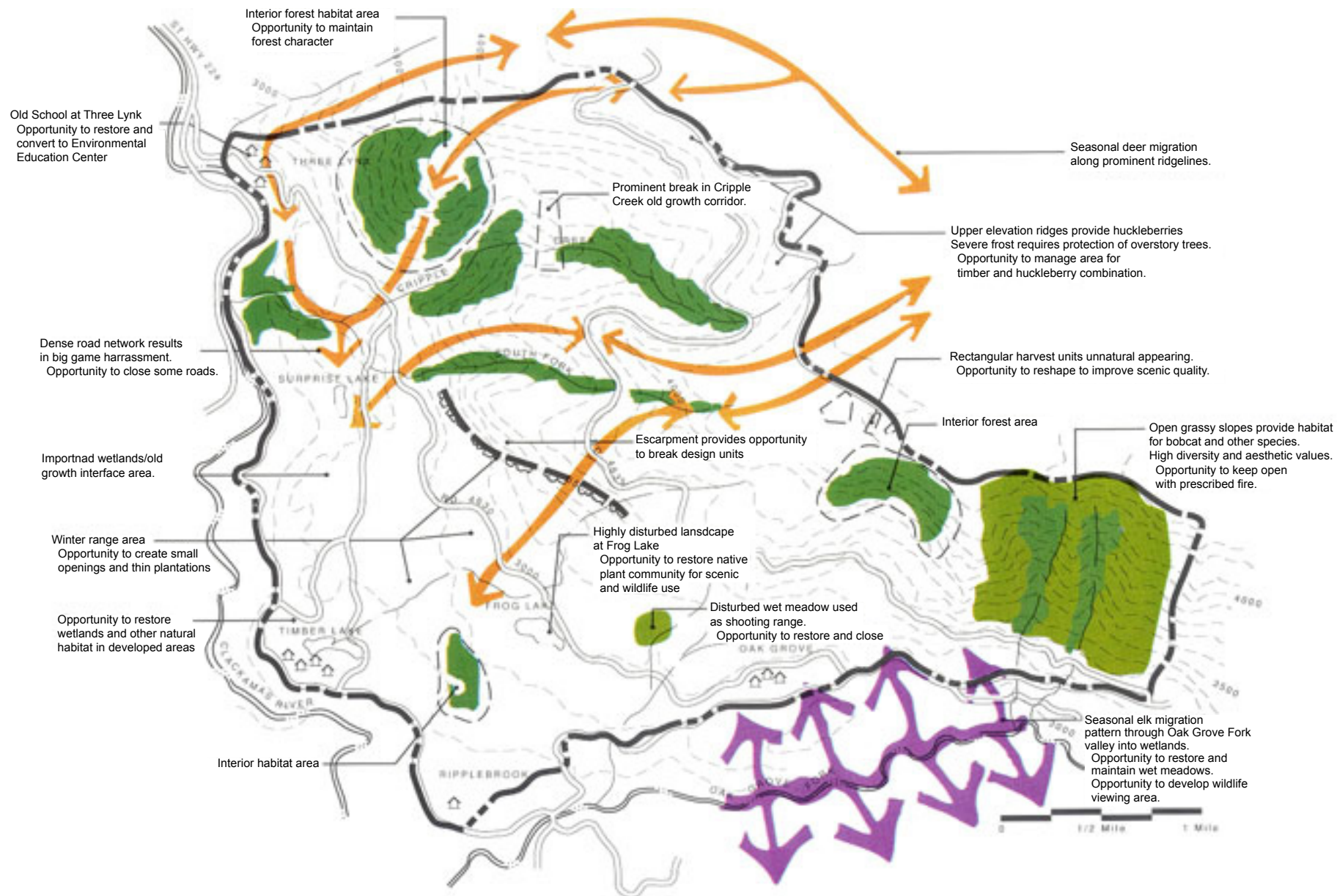


Figure 21 - Opportunities and constraints map



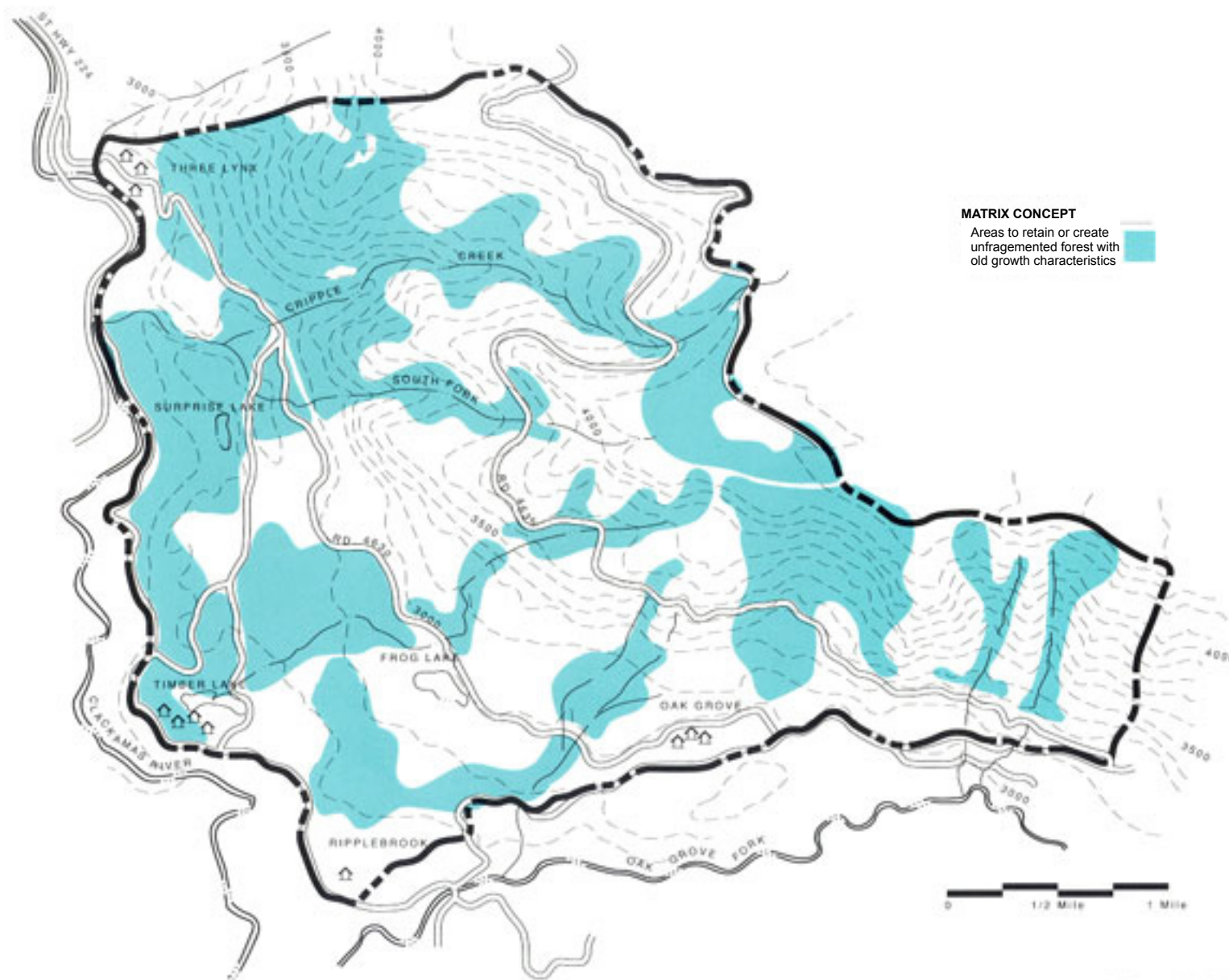


Figure 22 - Matrix concept

Fir Zone, based on the potential for huckleberries there. The “open brushy” areas correspond with existing patches.

A considerable amount of time was spent developing “concept designs” in a loose, free-flowing manner, trying to avoid getting too rigid too early on (Figure 23). Once the concept was acceptable, it was developed further by adjusting forms, testing in three dimensions, and adding thoughts on specific project opportunities that tie into the pattern (e.g. an elk viewing area). The final “Target Landscape Pattern” is combined with the “Illustrative Forest Design” to set the stage for future project design (Figures 24 and 25). Some reviewers of the Leoland design have remarked that it seems to show a lot of “mature forest” matrix. Is it realistic to call for selective management over such a large area? Yet, the design fits the Forest Plan intent for this area, which emphasizes wildlife and scenic values. If the Forest Plan had declared the whole site to be “Timber Emphasis”, then the design would have much less mature forest, but the patterns would still be fitted to the landforms.

The human circulation pattern for Leoland was determined primarily by looking at where people want and need to get to, how often, and by what means. The main road that provides access to high elevation trailheads on Mitchell Flat (Rd. 4635) was felt to be very important for recreation and management access, as was the road that follows the pipeline (Rd. 4630 and 4630-200). Several other roads are not essential, and have been recommended for closure in the winter range area in order to reduce poaching and harassment problems. Reconstruction of the Cripple Creek Trail has also been recommended in the design.



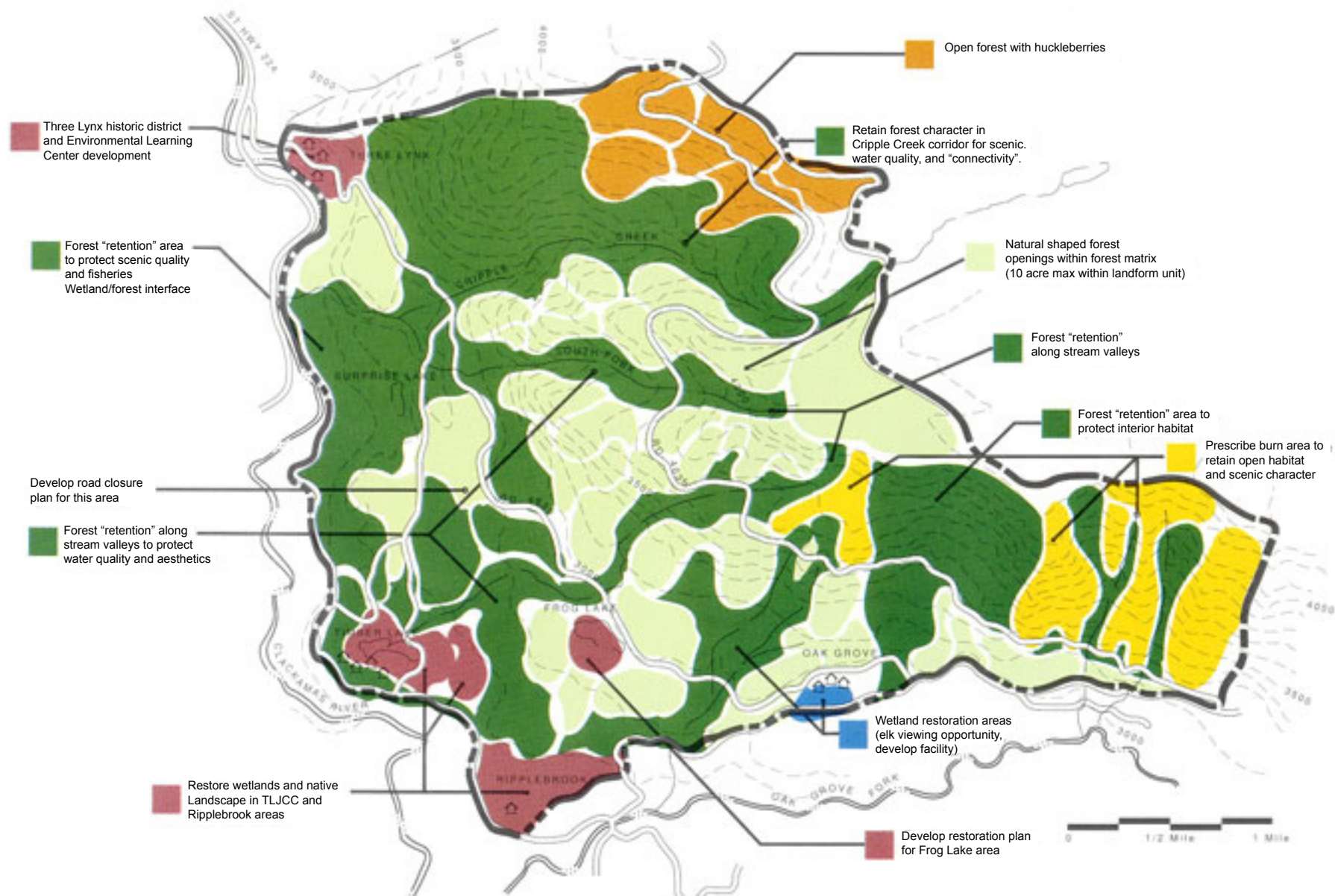


Figure 23 - Conceptual forest design

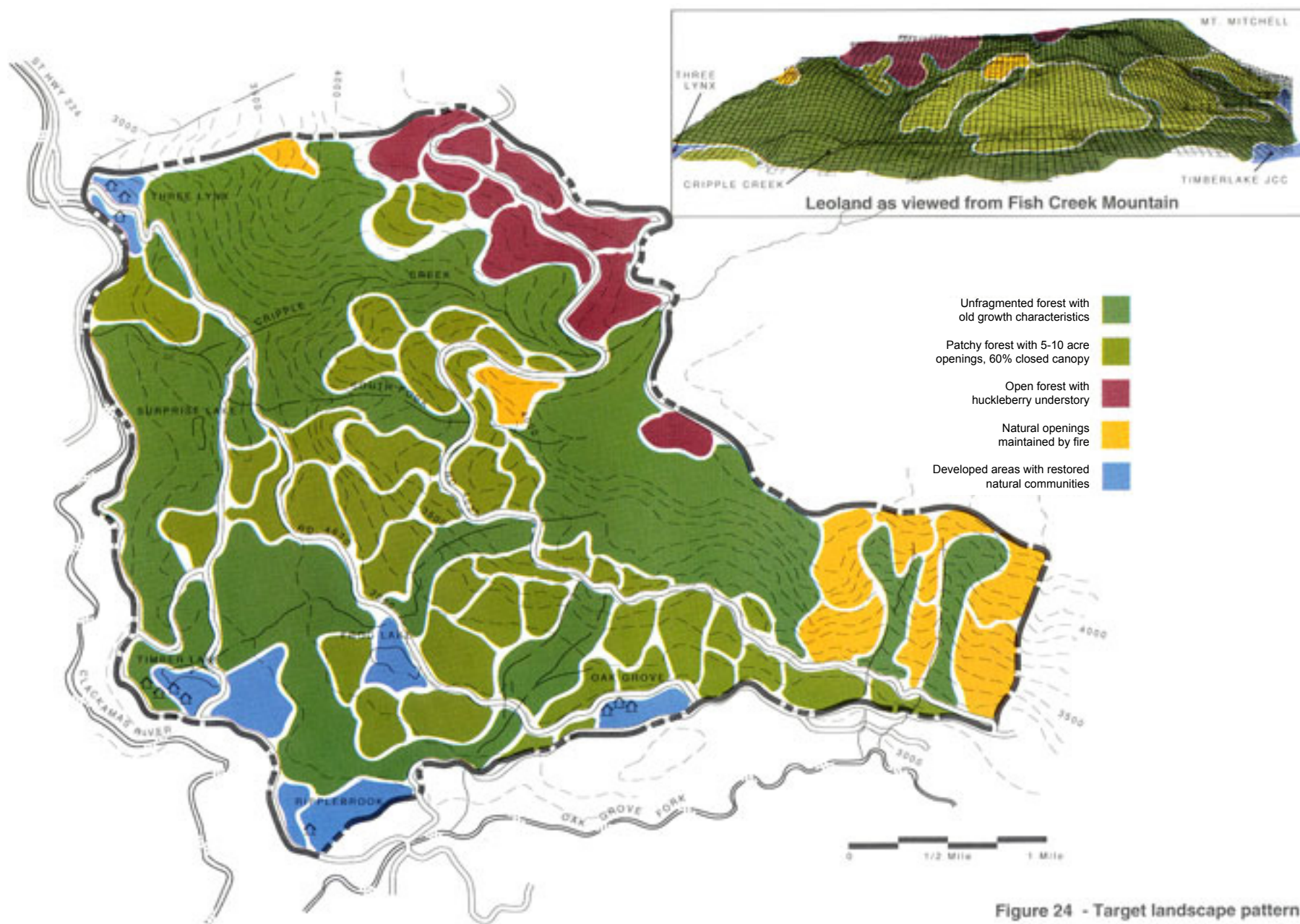


Figure 24 - Target landscape patterns



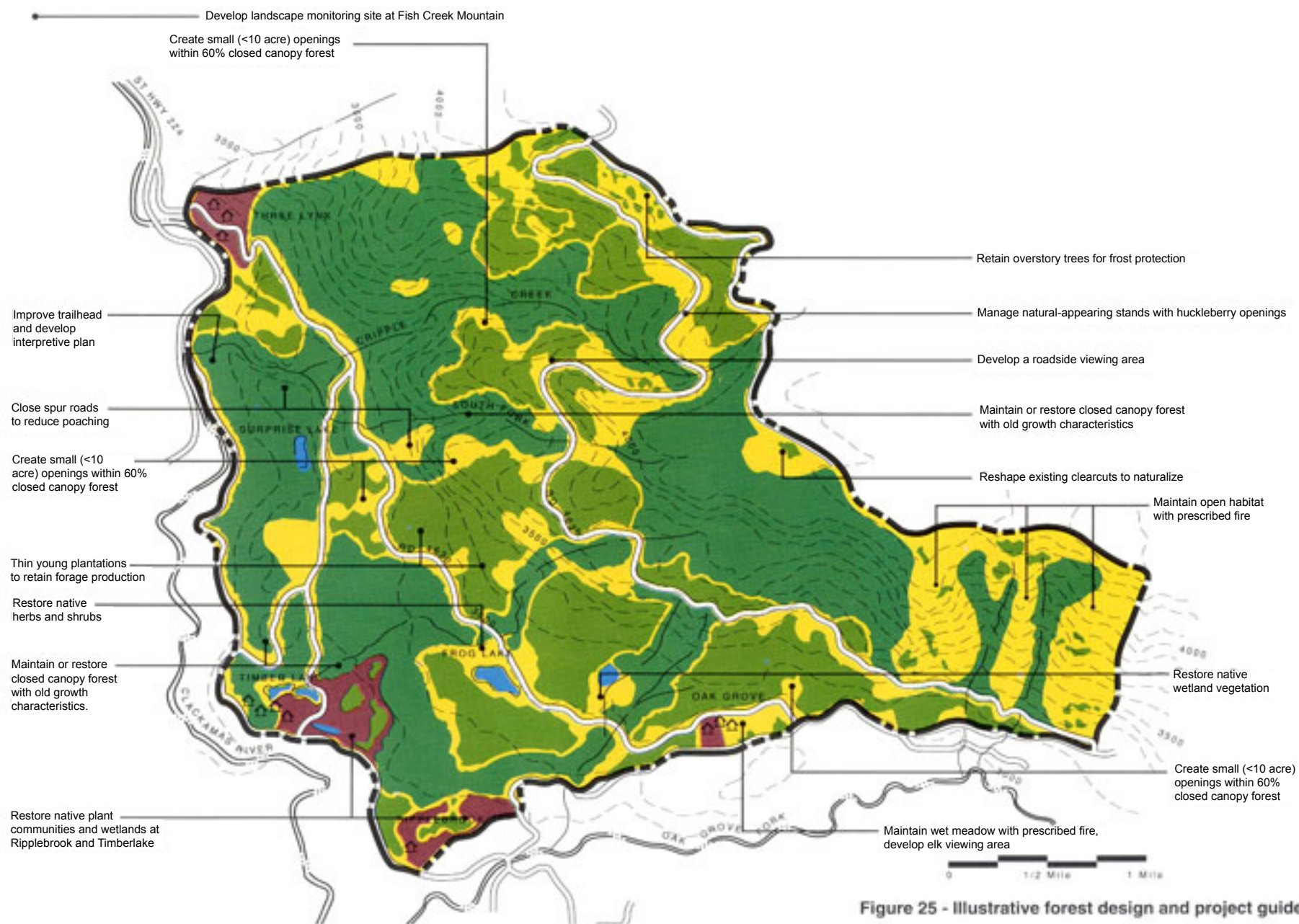


Figure 25 - Illustrative forest design and project guide

**NOW WHAT?**

Once the Step 8 is finished, the Landscape Analysis and Design process is complete. What does one do with the results? Chapter 3 discusses where this product fits in with conventional National Forest planning and design processes. One or more of the following uses will be appropriate:

- As the basis for generating proposals for projects
- As the basis for evaluating the effects of proposals on landscape level phenomena
- As a tool for communicating with the public about how implementation of projects will look aesthetically and function ecologically

Undoubtably, many questions will arise with application of this process. In the final Chapter, some that have arisen a number of times already are discussed. The hope is that the learning process will continue, with a wider circle of practitioners. For this reason, the authors invite comment about any of the concepts or procedures presented in this publication. Correspondence may be addressed to:

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CHAPTER 5

# Questions for Further Consideration







In the development and testing of the Landscape Analysis and Design Process, several questions emerged that did not have generic answers, mostly relating to the application of the Process in a given set of circumstances. Given the diversity of organizational structures, skills available and working relationships among those likely to use the Process, the answers will vary widely among different groups. But it seems important give some thought to these questions at some point, probably before the process is even started. Below are provided comments, NOT answers.

Q: Should there be only one target landscape, or should there be more than one, emphasizing different resources?

This question arose on a planning area where the NEPA process was being carried out in conjunction with the Integrated Resource Analysis. The concern was that the “target landscape” would circumscribe the development of a wide enough range of alternatives. There are two “fixes” for this: 1) to have more than one target landscape, and 2) to have alternatives that don’t achieve the target landscape. In practice, it is probably easier and more logical to choose “fix” #2. Since the analysis and design process is intended to achieve an integration of resource concerns, and to portray how the Forest Plan will be implemented on the ground, it has not seemed logical to have alternative target landscapes.

O: To what extent should outputs (i.e., timber volume, recreation visitor days, numbers of wildlife species, etc.) be used to generate the target landscape?

This will vary by planning group, depending on the circumstances and philosophy of local decision-makers. Generally, outputs are a measure by which the target landscape is evaluated, but not the basis for its generation. The focus should be on the landscape pattern that satisfies the Forest Plan and local resource concerns.

O: What is the best way to provide connectivity in landscapes - through corridors or within the matrix?

This is a question of considerable debate among ecologists. It depends largely on what species or flow connectivity is being provided for: for example, people travel better in corridors - roads or trails - than through the matrix, while highly mobile birds may depend less on corridors. The question must therefore be answered in the context of local landscape dynamics.

Q: What is the implementation timeframe for the target landscape (how long will it take to get there), and should there be checkpoints along the way?

The answer to this questions depends largely on how close to the target landscape pattern an area currently is. One approach is to specify a target landscape without worrying about how long it will take to get there, then develop some 10-, 20- or 50- year increments that show how the landscape pattern evolves as projects are implemented. This usually will need to happen in conjunction with development of individual projects and their implementation schedules.

O: Where do public involvement/participation/values fit in?

Again, the answer varies with individual circumstances. One possibility that seems workable in most situations is to elicit input about landscape patterns in the scoping stage, and then have a review of the target landscape pattern include interested and knowledgeable members of the public. There also have been instances where private citizens have been successfully involved in the actual development of the target landscape, along with the interdisciplinary team.

Q: What is an appropriate level of detail in the final design?

There are two considerations to address here: 1) there needs to be ENOUGH detail so that individual projects can be evaluated to determine whether they will help achieve the target landscape pattern; and 2) the design needs to be FLEXIBLE enough to allow for alternatives among and within projects (to satisfy NEPA requirements).

Q: What resources are needed to complete this task, and how much time should it take?

This process can be conducted by the kinds of resource specialists available to most any interdisciplinary team. Basic requirements are: a map of existing vegetative types, information about how wildlife, water, people, etc. use the landscape, and some basic understanding of natural processes within the area. The latter is often the most conjectural, and most difficult to get information about; it would be desirable to have an ecologist available to consult with regarding disturbances. In recent applications, it took 1 to 3 weeks to complete the Process for various analysis areas. It is important to note most of that time (2 of the 3 weeks in the latter case) involved the landscape architect working on Step 8. Steps 1 through 7 generally took 3 to 5 days. In general, existing information was used and additional data were not collected.

APPENDIX

# Common and Scientific Plant Names





**TREES**

Bigleaf maple  
Douglas-fir  
Mountain hemlock  
Noble fir  
Pacific silver fir  
Red alder  
Western hemlock

*Acer macrophyllum*  
*Pseudotsuga menziesii*  
*Tsuga mertensiana*  
*Abies procera*  
*Abies amabilis*  
*Alnus rubra*  
*Tsuga heterophylla*

**SHRUBS**

Big huckleberry  
Bitter cherry  
California hazel  
Dwarf Oregon grape  
Red huckleberry  
Red-flowered currant  
Redstem ceanothus  
Rhododendron  
Salal  
Scotch broom  
Snowberry  
Snowbrush ceanothus  
Sticky currant  
Thimbleberry  
Trailing blackberry  
Vine maple  
Western blackcap  
Willow

*Vaccinium membranaceum*  
*Prunus emarginata*  
*Corylus cornuta* var. *californica*  
*Berberis nervosa*  
*Vaccinium parvifolium*  
*Ribes sanguineum*  
*Ceanothus sanguineus*  
*Rhododendron macrophyllum*  
*Gaultheria shallon*  
*Cytisus scoparius*  
*Symphoricarpos mollis* or *albiflorus*  
*Ceanothus velutinus*  
*Ribes viscosissimum*  
*Rubus parviflorus*  
*Rubus ursinus*  
*Acer circinatum*  
*Rubus leucodermis*  
*Salix* spp

**FORBS AND GRASSES**

Beargrass	<i>Xerophyllum tenax</i>
Brackenfern	<i>Pteridium aquilinum</i>
Bunchberry dogwood	<i>Cornus canadensis</i>
Common brome	<i>Bromus vulgaris</i>
Fireweed	<i>Epilobium angustifolium</i>
Orchardgrass	<i>Dactylis glomerata</i>
Oxalis	<i>Oxalis oregana</i>
Pearly everlasting	<i>Anaphalis margaritaceae</i>
Queen Anne's lace	<i>Daucus carota</i>
Reed canarygrass	<i>Phalaris arundinaceae</i>
Swordfern	<i>Polystichum munitum</i>
Vanillaleaf	<i>Achlys triphylla</i>
White hawkweed	<i>Hieracium albiflorum</i>